ABSTRACTS OF LECTURES

AND POSTERS

EUROPEAN ORTHODONTIC SOCIETY

83rd Congress Berlin, Germany 2007
20-24 July

[The authors of abstracts marked (***) have either declared a financial interest or have not indicated whether or not they have a financial interest]

Oral Presentations

1 SHEAR BOND STRENGTHS OF BRACKETS AFTER RECYCLING ON NEW AND RE-PREPARED TEETH

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AIM: To compare changes in shear bond strength (SBS) of brackets recycled either by sandblasting or carbide bur cleaning, and to determine if a new enamel surface or a re-prepared tooth surface affects bond strength.
MATERIALS AND METHOD: One hundred and twenty new brackets and 180 extracted human premolars were used. In the first stage, the brackets were bonded to 120 teeth with composite resin, debonded and the bond strength recorded. The remaining 60 premolars were divided into two groups and kept for the second stage of the study. The debonded brackets were divided into two groups according to the recycling method: (1) sandblasted or (2) carbide bur cleaning, and the cleaning duration for each bracket was recorded. In the second stage, 60 recycled brackets in each group were divided into two subgroups according to the tooth surface. In each (1) sandblasted and (2) carbide bur cleaning groups, 30 recycled brackets were bonded to new premolar teeth while the remaining brackets were bonded to 30 used teeth after the enamel surfaces had been re-prepared. The brackets were again debonded and their bond strengths measured. Univariate analysis of variance was used to determine whether significant differences existed between recycling methods and tooth surface types.
RESULTS: The SBS of the sandblasted group was significantly higher than that of the carbide bur cleaned group. The SBS of the sandblasted group was not significantly different from that of new brackets, while the bond strength of brackets recycled by carbide bur cleaning significantly decreased. The tooth surface, either new or re-prepared, did not significantly affect the SBS of the sandblasted and carbide bur cleaned groups.
CONCLUSION: Sandblasting is an effective way of removing composite without significant change in SBS. The SBS of the brackets recycled by carbide bur cleaning was significantly lower than that of new and sandblasted brackets. Re-prepared tooth surfaces did not diminish the bond strength in either group, which is important in clinical practice.

2 HOW PERMANENT IS A PERMANENT RETAINER?

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AIM: To evaluate the correlation between retention time and the amount of post-retention relapse of lower anterior teeth retained with fixed bonded retainers.
MATERIALS AND METHOD: Two groups of study models, each consisting of 75 lower dental casts of 25 female patients. Group I wore a bonded retainer for 29 ± 3.6 months and group II for 45 ± 4.43 months. For both groups, study models were available before treatment (T1), at debonding (T2) and one year after retainer removal (T3). All cases were matched according to age, Angle classification, amount of initial crowding, extraction of premolars, and duration of active treatment. The study models were scanned at a resolution of 400 dpi using a Hewlett Packard 40-70 scanner. A computer program (Onyx ceph) was used to mark points on the photographs of the scanned casts following which Little's Irregularity Index (LII) and intercanine width were measured. The correlation between the extent of post-retention changes and retention time was analyzed. The reproducibility of the measurements for 45 scanned models at T1, T2, and T3 was determined and were within acceptable range. Pearson's correlation coefficient was used to assess the relationship of LII at T1, T2 and T3 and a two-sample *t*-test to evaluate relapse between the two groups.
RESULTS: There was no statistically significant difference at T1 and T2 between the two groups. The mean LII in group I was T1= 6.54 ± 3.8, T2 = 0.63 ± 0.87 and T3 = 2.36 ± 1.70 and in group II 5.72 ± 2.69, 0.27 ± 0.30 and 1.6 ± 2.2, respectively. Although significant differences were seen in both groups between T2 and T3, it was highly significant in group II ($P < 0.001$). Comparison of the groups at T3 showed statistically significant differences ($P < 0.01$); indicating that group II had less relapse than group I. No significant differences in intercanine width were observed either in or between the groups.
CONCLUSION: A significant positive correlation was seen between the amount of relapse and the duration of retention. Therefore, fixed bonded retention for a longer duration is recommended for improved stability.

3 A RANDOMIZED CLINICAL STUDY OF INTERCEPTIVE THERAPY OF PALATALLY DISPLACED CANINES

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AIM: To evaluate the effectiveness of two interceptive approaches to palatally displaced canines (PDC): extraction of the primary canines alone or in association with the use of cervical pull headgear.
SUBJECTS AND METHOD: This randomized prospective study comprised 75 subjects with a PDC (92 maxillary canines) who were randomly assigned to three groups: extraction of the primary canine only (EG); extraction of the primary canine and cervical pull headgear (EHG) and an untreated control group (CG). Panoramic radiographs were evaluated at the time of initial observation (T1), and after an average time period of 18 months (T2). At T2 the success or failure of canine eruption was evaluated. Between group statistical comparisons were undertaken on the T1-T2 changes using diagnostic parameters on the panoramic radiographs and the rates of success in canine eruption. A superimposition study on lateral cephalograms at T1 and T2 allowed evaluation of changes in the sagittal position of the upper molars in the three groups. The operator who performed the clinical and cephalometric analyses was blind as to the group the subjects were assigned to.
RESULTS: The removal of the primary canine as an isolated measure to intercept palatal displacement of maxillary canines showed a success rate of 65.2 per cent, which was significantly greater than the success rate in the CG (36%). The use of headgear in addition to extraction of the primary canine resulted in successful eruption in 87.5 per cent of the cases, with a significant improvement in canine position. Cephalometric superimposition showed significant mesial movement of the upper first molars in the CG and EG when compared with the EHG.
CONCLUSIONS: Extraction of the primary canine appears to be an effective procedure to increase the rate of normal eruption of maxillary PDC (twice that of the untreated controls). The use of cervical pull headgear in addition to the extraction of the primary canine was able to significantly increase the rate of successful eruption of the permanent canine (almost 3 times that of untreated controls). The additional use of headgear resulted in reduced physiological mesial movement of the upper first molars (2 mm).

4 PALATAL IMPLANTS IN ADOLESCENTS: A HISTOLOGICAL EVALUATION IN BEAGLE DOGS

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AIM: Small osseointegrated implants inserted in the palate provide reliable anchorage control during orthodontic treatment. When these implants are inserted in the median palatal suture in adolescent dogs, it has been shown, biometrically and radiographically, that normal transverse maxillary growth is restricted. The aim of this study was to find histological confirmation of these results and to describe the repair process which takes place in the palatal suture after removal of an orthodontic implant.
MATERIALS AND METHOD: Five adolescent beagle dogs were used, one of which was randomly selected as a control dog. Each test dog received two implants in the median palatal suture. The experimental period was 25 weeks, during which the dogs were subjected to a regimen of sequential point labelling with vital staining every 6 weeks. At the end of the examination period, the dogs were sacrificed and the specimens prepared for histological evaluation.
RESULTS: Restricted transverse maxillary growth of the maxilla was observed in the test dogs when compared with the control dog. Repair of the bone in the sutural area was faster at the caudal side. The typical Y-shaped form was repaired but the vertical leg was straight and broad, instead of having a sinusoidal course, as was observed in the control dog. This broad and straight course of the vertical leg of the Y was similar to the palatal suture in the infantile stage in humans. Maybe, because of the insertion of the implant, a temporary restriction in transverse growth was present, but once the suture is restored (and resembles that during the infantile stage of development), catch up growth may occur. This question is interesting but cannot be answered by the results of the present study.
CONCLUSION: In adolescents, palatal implants should not be inserted in the median palatal suture.

5 COMPARISON OF ROOT RESORPTION AFTER 4 VERSUS 8 WEEKS OF LIGHT AND HEAVY FORCES

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AIM: After successfully establishing the extent of root resorption in three dimensions (volumetric analysis), the fourth dimension (time) was explored. The aim of this study was to compare the extent of root resorption in human first premolar teeth after the application of light and heavy controlled orthodontic forces at 4 and 8 weeks.
MATERIALS AND METHOD: Forty-three human first premolar teeth divided into two groups. Group I had an experimental period of 4 weeks and group II, 8 weeks. Within each group there were separate controls and buccally directed light (25 g) or heavy (225 g) orthodontic force applications. The forces were not reactivated during the experimental periods. All samples were prepared and scanned by microcomputed tomography. After cone-beam reconstruction, three-dimensional images were produced and the volume of root resorption craters obtained and analysed.

RESULTS: Using Bonferroni adjustment for multiple comparisons, there was more root resorption in the heavy force group as compared with the light force group and controls ($P < 0.001$). There was also more root resorption in the 8-week group compared with the 4-week group and their controls ($P < 0.001$). ANOVA analysis showed there was significantly more root resorption in the 8-week heavy force group as compared with the controls, 4-week light force, 8-week light force and 4-week heavy force groups ($P < 0.001$), with the latter three groups showing no significant difference between each other.
CONCLUSION: Under a prolonged 8 weeks of heavy force activation, it is postulated that hyalinization and undermining resorption occurs within the periodontal ligament prior to tooth movement. Consequently, minimum force decay and tooth movement occurs and the force sustained at that level propagates a further increase in levels of stress which resulted in more root resorption when compared with the other groups.

6 NEW REGRESSION EQUATIONS FOR MIXED DENTITION ARCH ANALYSIS

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AIM: To derive new regression equations from 228 patients (100 males, 128 females) with no intermaxillary tooth size discrepancy, and to establish which would give the greatest correlation coefficient for the sum of the permanent tooth widths of the canine and premolars in both arches, according to gender.
MATERIALS AND METHOD: Mesiodistal tooth widths were measured from dental casts according to the technique proposed by Moorrees. Student's *t*-tests were carried out to compare tooth sizes between genders and between the right and left sides of the arches. The constants, a and b, in the standard linear regression equation ($y = a + bx$), the correlation coefficients (r), coefficients of determination (r^2) and the standard errors of the estimates (SEE), were calculated.
RESULTS: Significant differences were found between the tooth widths of male and female subjects both in the maxillary ($P < 0.01$) and mandibular ($P < 0.001$) arches. The r value ranged from 0.956 to 0.989, with the higher coefficients in females. The r^2 values ranged from 91 per cent in males to 98 per cent in female, and the SEE was better in the maxilla and mandible (0.013 mm) for females. The regression equations produced predictions of the canine and premolar mesiodistal width summations which were different from other reported studies.
CONCLUSION: Tanaka and Johnston prediction equations and Moyers' probability tables should be revised by using subjects with no tooth size discrepancy.

7 DIFFERENTIAL RESPONSE OF PERIODONTAL LIGAMENT AND DENTAL IMPLANTS TO MECHANICAL LOADING

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AIM: The periodontal ligament (PDL) contains pluripotential cells that can differentiate to osteoblasts. Cells surrounding dental implants are fully differentiated osteoblasts. It has been shown that mechano-stimulated PDL cells induce the bone-specific transcription factor (TF) Runx2, via an ERK-dependent pathway, suggesting that the mechanical load in PDL cells induces differentiation, triggers bone remodelling and results in architectural changes in the alveolar bone. Despite mechanical load application, dental implants cannot be moved. Whereas Runx2 is one of the earliest regulatory transcription factors (TFs), Osterix is a TF that contributes to osteogenesis in fully differentiated osteoblasts, following Runx2 expression. The response of Runx2 and Osterix to mechanical load was investigated in order to explain the differential behaviour of the PDL and dental implant surrounding tissue.
MATERIALS AND METHOD: PDL cells were cultured under standard culture conditions and subjected to mechanical stretch from 1 to 6 hours. Osterix and Runx2 expression after mechano-stimulation was monitored by RT-PCR. In some experiments, cells were treated for 1 hour with the ERK/MEK specific inhibitor U0126 before mechanical stimulation. Lipofectamine+- 2000 was used for transfection of small interfering RNAs (siRNAs).
RESULTS: Mechanical stretching triggered expression of Runx2 as early as 30 minutes. Osterix expression was unaffected after 1 hour of mechano-stimulation, but a two-fold induction was observed after 3 hours of continuous stretch and remained unaltered until the maximum time of stretching (6 hours). Stretching the cells for 1 hour and leaving them for two additional hours unstretched resulted in the same two-fold induction of Osterix. Moreover, using siRNA to silent Runx2 expression and then stretching the cells for 3 hours, did not affect Osterix levels. In contrast, cells transfected with a non-specific siRNA responded similarly to untransfected PDL cells and displayed induction of Osterix expression after mechano-stimulation. Treatment of PDL cells with the ERK/MEK inhibitor U0126 prior to strain application abolished the effects of stretching on the expression of both Runx2 and Osterix, suggesting that mechanical stress induces Osterix expression in PDL cells through an ERK/Runx2 dependent mechanism.

CONCLUSION: It seems that only pluripotential cells retain the advantage of being able to respond to mechanical load, by mechanisms that ultimately result in architectural changes in the surrounding bone.

8 MAPPING BUCCAL CORTICAL BONE THICKNESS WITH CONE BEAM COMPUTED TOMOGRAPHY FOR MINI-IMPLANT INSERTION

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AIM: To create a map of the buccal cortical bone thickness in the interproximal areas of the dentition as an aid to planning orthodontic mini-implant insertion.
MATERIALS AND METHOD: Computer tomographic scans of 30 skulls were obtained with a cone beam computed tomography scanner. The three-dimensional data were processed and slices through each interproximal contact area were generated on which measurements of buccal cortical bone thickness were carried out at 2, 4 and 6 mm from the alveolar crest. Intraclass correlation coefficients were used to ensure intra-rater reliability and one-way analysis of variance was employed to detect significant differences in bone thickness.
RESULTS: Depending on the anatomical site, buccal cortical bone thickness ranged from 0.75 to 1.39 mm in the maxilla and from 0.82 to 3.12 mm in the mandible. In general, for the maxillary buccal segments, buccal cortical bone thickness was greatest at 6 mm from the alveolar crest and thinnest at 4 mm, whilst in the maxillary anterior segment it was greatest at 6 mm and thinnest at 2 mm. In the mandible, buccal cortical bone thickness was greatest at 6 mm from the alveolar crest and thinnest at 2 mm. In both jaws the thickness increased from the anterior to the posterior.
CONCLUSION: Interproximal buccal cortical bone thickness varies within the human jaws and certain patterns can be identified. Knowing the average thickness of cortical bone in various areas can aid the orthodontist in mini-implant site selection.

9 SEXUAL DIMORPHISM OF THE HUMAN JAW CLOSING MUSCLES

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AIM: The predictability of surgical mandibular advancement procedures is sometimes compromised by relapse. Relapse appears to have a multifactorial aetiology, but vertical craniofacial morphology (long-face), jaw muscle function and gender are regarded as important contributing factors. Therefore, the aim of this study was to explore to what extent sexual dimorphism is present in the human masticatory system.
SUBJECTS AND METHOD: Eighty-four (55 males, 29 females) healthy adult subjects with varying vertical craniofacial morphology. Contiguous 30 degree angulated magnetic resonance imaging scans (orientated relative to the Frankfort Horizontal plane) were taken of the masseter and medial pterygoid muscles. This scan orientation was chosen to visualise the cross-sections as near as possible to the direction of muscle orientation. The outlines of the muscles were subsequently segmented and digitised using customised software (Vision). The maximum cross-sectional areas of the muscles were recorded as this represents the maximum isometric contraction strength of the muscle. Cephalometric analysis was performed using lateral radiographs.
RESULTS: The cross-sectional areas of the medial pterygoid and masseter of males were up to 20 per cent larger than those of females. This difference was significant ($P < 0.01$). Furthermore, regression analysis showed that in males jaw muscle cross-sectional area was significantly related to the palatal plane-mandibular plane (up to $R = 0.67$ $P < 0.01$). No such relationships were found in females. In females mutual associations between jaw muscle function and vertical craniofacial morphology were weak. Therefore, it may be postulated that a change in skull shape induced by orthognathic surgery is not necessarily followed by adaptation of the jaw muscle, and hence, may initiate relapse.
CONCLUSIONS: The jaw closing muscles of males are significantly larger than those of females. In males the correlation between muscle cross-sectional area and vertical skull shape is stronger than in females.

10 OSSEOINTEGRATED PALATAL IMPLANT VERSUS DENTAL ANCHORAGE IN ADOLESCENTS: A RANDOMIZED CONTROLLED STUDY

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AIM: Clinical comparison of osseointegrated palatal implant (PI) supported anchorage with conventional dental anchorage (DA) for two-phase (1. canines, 2. incisors) retraction, in extraction cases requiring 'maximum anchorage', in growing patients after the post-pubertal growth spurt.

SUBJECTS AND METHOD: Thirty patients with homogeneous facial skeletal characteristics (mean age: 14.22 ± 1.37 years) were randomly allocated to two groups. In the PI group (n = 15, mean age 14.15 ± 1.2 years) Orthosystem® implants were placed in the palate for absolute anchorage and in each case a 1.2 × 1.2 mm thick rigid transpalatal arch (TPA) was fixed to the implant and to the molar bands by laser welding. In the DA group (n = 9, mean age 14.3 ± 1.57 years), maximal anchorage was provided by a TPA and a 0.017 × 0.025 inch stainless steel utility arch. A superelastic closed-coil spring was used for canine retraction. Sequential activation of the 'teardrop' closing loop of the stainless steel contraction arch was used for incisor *en masse* retraction. The main outcome measures were duration of the orthodontic treatment phases and cephalometric analysis of maxillary first molar movement. After explantation, all implant surfaces were histologically evaluated using Bioquant Osteo software.
RESULTS: No significant differences ($P = 0.47$) were observed between the groups regarding the duration of closure of the extraction space. In the PI group, the duration of incisor retraction ($P < 0.001$) and total treatment time were shorter ($P < 0.05$). A significant difference in mesial molar movement was found in both treatment phases ($P < 0.05$). Molar anchorage loss was 3.77 ± 2.34 mm in the DA group, twice as much as in the PI group ($P < 0.05$). Bone implant contact was observed for 69.9 ± 21.6 per cent of the whole implant surface.
CONCLUSION: Stable implant supported anchorage was demonstrated. The possible maximum anchorage was proved in this study. A shorter orthodontic treatment period was achieved using the palatal implant, compared with dental anchorage. The use of the palatal implant was without complication, representing a safe alternative in growing adolescents for maximum anchorage cases.

11 FRICTIONAL RESISTANCE OF SELF-LIGATING AND STANDARD EDGEWISE BRACKETS

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AIM: Bracket design and type of ligation have a crucial influence on the frictional resistance in tooth movement. It was the aim of this study to further investigate the differences in frictional behaviour between various self-ligating bracket systems and standard edgewise brackets.
MATERIALS AND METHOD: The following brackets in the 0.022 inch slot system were investigated: Time (ADenta), Quick (Forestadent, with passive and active clip), Oyster and In-Ovation (GAC), Damon2 and Damon3 (Ormco), Speed (Strite), MIM-Opal and Opal2 (Ultradent), and Smartclip (3M Unitek). The conventional brackets, Discovery and Ultratrimm (Dentaurum), were included for comparison. The Orthodontic Measurement and Simulation System was used to experimentally simulate canine retraction. The following archwires were selected (dimension 0.43 × 0.64 mm): stainless steel (SS; Remanium, Dentaurum), nickel titanium (NeoSentalloy, GAC), and titanium molybdenum alloy (TMA, Ormco). A NiTi closing coil was chosen as the active element (GAC, almost constant force of 0.5 N). The applied and orthodontic effective forces were measured and the difference between them represented the frictional resistance of the material combination under investigation. Five brackets each were measured and each measurement was repeated five times. The mean and standard deviations were calculated.
RESULTS: Force loss due to friction varied significantly between the different bracket and wire types. Frictional losses ranged from 24 per cent (Opal and SS wire) to more than 80 per cent (Speed, TMA). The other self-ligating systems and the conventional brackets, Discovery and Ultratrimm, showed frictional losses between 25 and 40 per cent. Generally, active clips resulted in higher force loss due to friction. Using NiTi or TMA wires resulted in frictional losses that were higher by about 30 per cent for all products compared with the SS wire. For these wires, plastic brackets had lower frictional losses than brackets made of SS.
CONCLUSIONS: Self-ligating brackets are not 'zero-friction' or 'low-friction'. High friction occurs with active clips during tooth movement. The alternative, to use a clip in active or passive configuration, is a clear benefit in controlling tooth movement.

12 PATIENT PERCEPTION, TREATMENT NEED AND COMPLEXITY OF ORTHODONTIC RE-TREATMENT

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AIM: An increasing number of patients attend for orthodontic re-treatment. The subjective and objective treatment needs of these patients have not been investigated. The aim of this study was to evaluate these patients' perceptions of dental aesthetics and treatment need and complexity.
SUBJECTS AND METHOD: One hundred subjects seeking re-treatment were asked to complete a questionnaire that was constructed based on a pilot interview with 15 patients. Questions focussed on treatment experiences and retention procedures of the first course of treatment, and expectations and motivations for re-treatment. A visual analogue scale (VAS

0-10) was used. The 're-treatment' group was matched for age, gender and first consultation date with a control group who had not undergone previous treatment. The study models of both groups were scored with the Index of Complexity, Outcome and Need (ICON).
RESULTS: Eighty-eight patients (mean age 26.3 ± 8.4 years) completed and returned the questionnaire. During the initial treatment, different appliances were used; with 47.7 per cent having full fixed appliances, while 40 per cent of the patients in this group did not have any retention. The mean VAS scores for dental aesthetics at the start and end of the initial treatment were 2.3 ± 2.1 and 6.6 ± 2.7, respectively. The scores for the present situation and expected results of re-treatment were 4.1 ± 2.7 and 8.8 ± 1. These scores differed significantly from each other ($P < 0.01$). The VAS score for motivation was 8.1 ± 2.4, which was significantly different to the score for the initial treatment i.e. 6.5 ± 2.6 ($P < 0.01$). Seventy-seven pairs of models were matched for evaluation of treatment need and complexity. The mean ICON scores of the re-treatment group were significantly lower than the controls; 45 ± 21 compared with 57 ± 24 ($P < 0.01$), with the aesthetic component being the main contributor to this difference (25 ± 16 versus 36 ± 18, $P < 0.01$). However, both groups indicated a need for treatment (ICON >43), with 72 per cent of the re-treatment patients and 48 per cent of the controls having a 'mild' treatment complexity, and 10 and 28 per cent, respectively, 'very difficult'. The percentage of 'moderate-to-difficult' cases was similar in the two groups.
CONCLUSION: Patients seeking re-treatment had a good perception of dental aesthetics and strong motivation. These patients did have a treatment need, although the treatment complexity was relatively lower than the controls.

13 SURVIVAL RATE OF THIRTY-FOUR MINISCREWS – A PROSPECTIVE CLINICAL STUDY

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AIM: To determine the survival rate of the Aarhus mini-implant system during orthodontic therapy.
SUBJECTS AND METHOD: Twenty-one patients (8 males, 13 females) were included in this prospective clinical study after ethical approval was obtained. Thirty-four Aarhus mini-implants, self-tapping screws with a diameter of 1.5 mm and a length of 9.6 or 11.6 mm, were inserted monocortically during a one-stage procedure under local anaesthesia. After healing of the surrounding soft tissues, the screws were loaded either directly or indirectly for orthodontic purposes. For each miniscrew the loading force was measured with a spring scale; the clinical progress and any loss of stability were documented.
RESULTS: Seven screws were placed in the upper and 27 in the lower jaw: 26 in the premolar, three in the molar and five in the anterior region. The mean time of loading post-insertion was 19.6 days. Six screws were loaded indirectly, 27 directly with a force up to 300 cN. A total of six screws were lost: one before loading, five failed after a mean time of 90.2 days. All of these had been loaded directly. Most failures (5 screws) were observed in the premolar region, having been inserted immediately after tooth extraction. The overall success rate was 82.3 per cent. No statistically significant differences were noted between failure rate and gender, age or screw dimension.
CONCLUSION: The Aarhus system represents a transitional skeletal aid for achieving maximum orthodontic anchorage. The results of the present investigation show a success rate (82.3%) comparable with the data reported in literature (83.2 ± 12.0%). Because of the high screw loss rate in the premolar region, it appears sensible to avoid this region when planning screw positioning.

14 CONE BEAM COMPUTED TOMOGRAPHIC DATA FOR DIAGNOSIS IN DAILY ORTHODONTICS

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AIM: To demonstrate the use of cone beam computed tomography (CBCT) data for diagnosis and treatment.
MATERIALS AND METHOD: In more than 500 orthodontic patients CBCT data were used for routine orthodontic treatment planning. The CBCT data were obtained using either the Mercuray (Hitachi, Japan) or the iCAT (ISI, USA) scanner. The resulting DICOM data can be imported into specific software programs (i.e. Dolphin 3D, InVivoDental, Maxilim, Simplant CMF) and further evaluated for specific diagnostic needs. Three-dimensional (3D) soft and hard tissue cephalometric analysis is the routine method for evaluation. In addition, the upper nasal and pharyngeal airways, as well as the sinus, are studied. The individual arch form of the patients is determined with the help of axial slices. In every adult patient the amount of vertical bone loss is determined. The thickness of the lingual and buccal bone is also quantified to avoid gingival recession. 3D evaluation of the temporomandibular joints is another routine feature in daily orthodontic diagnostic. Furthermore, orthognathic surgery planning and diagnostic of impacted teeth is significantly improved.
RESULTS AND DISCUSSION: Within the last 5 years the number of CBCT scanners has increased in the United States from 5 to 500. CBCT scans will help the orthodontist to overcome the long-term disadvantage of using two-dimensional

diagnosis in patients. The clinical information is significantly better than with conventional lateral cephalograms and panoramic radiographs. The acquisition time for the new 3D scans can be chosen between 10, 20 or 40 seconds resulting in different resolutions. The CBCT data consists of 300 to 600 single images. Depending on the field of view, the radiation dose varies between 30 and 135 μS, which is lower than the dose of a periapical radiograph.
CONCLUSIONS: CBCT provides significantly more information for treatment planning than conventional radiographs. In the near future CBCT will become the standard diagnostic tool. Since the scanner is expensive it is not designed for the orthodontic office, but for specialized imaging centres.

15 SAGITTAL AIRWAY DIMENSIONS FOLLOWING MAXILLARY PROTRACTION

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AIM: To evaluate the effects of Le Fort 1 corticotomy assisted facemask therapy on craniofacial structures and upper airway dimensions, and to compare the treatment outcomes with the effects of rapid palatal expansion (RPE) assisted facemask therapy in the treatment of growing Class III maxillary retrognathic patients.
SUBJECTS AND METHOD: Group 1 comprised 16 patients (10 females, 6 males) with a mean age of 12.75 ± 1.91 years and group 2, 16 patients (7 females, 9 males) with a mean age of 12 ± 1.7 years. Pre- and post-treatment cephalometric radiographs were evaluated.
RESULTS: In both groups point A moved anteriorly (SNA, Nper-A, Max Depth increased, $P < 0.05$), the mandible showed clockwise rotation (SNB decreased, SN-MP angle increased, $P < 0.05$), the head moved to a more extended position (SN-CVT increased $P > 0.05$) in relation to the cervical vertebrae. In group 2, the palatal plane showed counterclockwise rotation as confirmed by the 1.66 ± 1.81 degree decrease in SN-PP angle ($P < 0.01$). Oropharyngeal airway dimensions (SPS, MPS, IPS) did not change significantly in either group, however nasopharyngeal airway dimensions increased significantly in both groups, as confirmed by the 2.42 and 3.36 degree increases in PNS-ad2 in groups 1 and 2, respectively. The increase in maxillary depth and anterior movement of soft tissue point A were found to be significantly different in the two groups, both measurements increased more in group 1 (3.75 ± 3.13 degrees, 5.25 ± 3.31 mm, $P < 0.05$). Multiple regression analysis demonstrated that in group 1 the changes in SNB and SN-MP had a significant effect on IPS (inferior oropharyngeal airway dimension), in group 2 the changes in SNA, SNB, PL-CVT had a significant effect on IPS.
CONCLUSIONS: Maxillary protraction in growing patients, with or without RPE, could contribute to an increase in upper airway dimensions, mostly in nasopharyngeal airway space. Corticotomy assisted maxillary protraction without RPE appears to cause less counterclockwise palatal rotation.

16 GENETIC FACTORS IN ORTHODONTICALLY INDUCED INFLAMMATORY ROOT RESORPTION

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AIM: Orthodontic induced inflammatory root resorption (OIIRR) is an undesirable sequel of treatment. Many factors are involved including gender, teeth, malocclusion, movement type, orthodontic force magnitude, duration and type of force. Recent studies have confirmed strong heritability of OIIRR. Linkage and linkage disequilibrium was found between interleukin 1B (IL-1B) gene polymorphism and OIIRR in orthodontically treated individuals. The role of IL-1 in bone resorption during orthodontic tooth movement is widely accepted; variations of IL-1 levels are related to the amount of tooth translation and might contribute to OIIRR. Another polymorphism in gene IL-1A (+4845) on the long arm of chromosome 2 has been described. IL-1+ genotype, which is a combination of IL-1A +4845 allele2 and IL-1B +3954 allele2, is associated with periodontal disease. The aim of this study was to test the association between OIIRR and the IL+ composite genotype using a case-control design.
MATERIALS AND METHOD: Clinical records of 187 patients who had received fully-banded comprehensive orthodontic treatment were examined. Eighteen subjects with severe root resorption (cases) and 28 subjects with no signs of root resorption (controls) were selected. Polymerase chain reaction was used to diagnose polymorphisms. Linkage disequilibrium between IL-1 polymorphisms and OIIRR was investigated.
RESULT: Significant evidence of an association was obtained for case-control status, IL-1B polymorphism and IL+ genotype; whereas no association was found for case-control status and IL-1A polymorphism. The odds ratio associated with IL+ was 0.2 (95 per cent confidence intervals 0.05-0.85; $P = 0.03$) indicating that teeth are five times less likely to have root resorption when the patient has this genotype. The protective effect of IL-1+ may be the consequence of an increased bone turnover during orthodontic movement that is found in patients with this genotype.
CONCLUSION: The genotype IL-1+ represents a protective factor for OIIRR. These findings confirm a key role of genetic factors in OIIRR.

17 EXPRESSION OF SOX 9 AND TYPE II COLLAGEN IN THE SPHENO-OCCIPITAL SYNCHONDROSIS

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AIM: Cranial base synchondroses are important growth centres of the craniofacial skeleton, especially the spheno-occipital synchondrosis because of its late ossification and major contribution to post-natal cranial base growth. It develops from a cartilaginous template that is eventually replaced by bone through endochondral ossification. Endochondral ossification is modulated by a cascade of events from various factors. SOX 9 is a key transcription factor in governing chondrocyte differentiation. It also directly activates the expression of type II collagen that acts as an early main marker of the chondrocytes and forms the framework of the cartilage matrix. Therefore, it is important to understand the mechanism of SOX 9 and type II collagen in the development of synchondroses. The aim of this research was to establish the temporal pattern of SOX 9 and type II collagen expression, with or without tensile stress, in order to understand the role of these factors in the growth of cartilage in the spheno-occipital synchondrosis.
MATERIALS AND METHOD: Sixty, 1-day-old, male balb/c mice were randomly divided into experimental and control groups. Each group was subdivided again into five different time frames; 6, 24, 48, 72 and 168 hours. Each subgroup consisted of five mice. Each mouse was sacrificed using an intraperitoneal injection of overdose chemical anaesthetic, pentobarbitone sodium (150-200 mg/kg). The spheno-occipital synchondrosis was aseptically removed and incubated in a 24-well plate, with or without tensile stress, in tissue culture at 37ºC and 5 per cent CO_2. Tissue sections were subjected to immunohistochemical staining for quantitative analysis of SOX 9 and type II collagen expression.
RESULTS: There was a significant increase (57%; $P < 0.001$) in the expression of SOX 9 between control and experimental groups at 24 hours. This was followed by a significant increase (44.4%; $P < 0.001$) of type II collagen expression in the experimental groups at 72 hours compared with the control groups in the same time frame.
CONCLUSION: Tensile stress increases the expression of SOX 9 and type II collagen synthesis in the spheno-occipital synchondrosis. SOX 9 is an essential factor for early differentiation of chondrocytes, and for type II collagen synthesis during cartilage growth in spheno-occipital synchondrosis.

18 SKELETAL ANCHORAGE FOR ORTHOPAEDIC CORRECTION OF GROWING CLASS III PATIENTS

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AIM: When a retrusive midface is present in a Class III growing patient, maxillary protraction can be used to achieve forward skeletal movement of the maxillary complex. One of the limitations in maxillary protraction with tooth-borne anchorage devices is loss of dental anchorage especially when used in relatively older patients or those in the mixed dentition. To minimize this loss of dental anchorage, intentionally ankylosed maxillary primary canines or osseointegrated titanium implants can be used as anchorage for protraction treatment. Although these treatment modalities are reasonable, the methods have many clinical limitations and some are impractical and costly. Skeletal anchorage (e.g. microscrews or miniplates) is gaining popularity as a source of anchorage in orthodontics. However there are only a few published reports about its orthopaedic application in Class III treatment. The aim of this investigation was to compare the short-term cephalometric changes with those achieved with a conventional rapid maxillary expansion (RME) and protraction headgear combination.
SUBJECTS AND METHOD: Forty growing patients with Class III maxillary retrusion were randomly divided into two groups. Group 1 was treated with conventional RME and protraction headgear, while group 2 received miniplates and maxillary protraction headgear. Cephalograms, taken before and immediately after protraction treatment, were traced and analysed. Repeated ANOVA was used to compare the treatment effects between the two groups.
RESULTS: Treatment time, age and cephalometric variables at the beginning of treatment showed no statistical differences between the two groups. There were statistically significant differences between groups 1 and 2 as a result of treatment. Treatment using miniplates (group 2) resulted in a larger increase in SNA compared with conventional protraction headgear treatment (1.7° for group 1, 3° for group 2). In group 2 only minimal mesial movement of the upper molars occurred (2.1 mm in group 1, 0.3 mm in group 2) and the amount of upper molar extrusion was minimal (1.3 mm in group 1, 0.2 mm in group 2), which is crucial for Class III treatment in growing children.
CONCLUSIONS: Maxillary protraction using miniplates can improve orthopaedic correction without the dentoalveolar movements which occur with conventional anchorage. In addition, the surgical procedure is relatively simple.

19 CEMENTUM REPAIR 4 AND 8 WEEKS AFTER LIGHT AND HEAVY FORCE APPLICATION FOR 4 WEEKS

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AIM: To evaluate the amount of cementum repair by measuring and quantitatively comparing the volumetric changes of root resorption craters after 4 and 8 weeks retention periods following 4 weeks of continuous light and heavy orthodontic force application.
SUBJECTS AND METHOD: Forty patients who required bilateral extraction of maxillary first premolars as part of their orthodontic treatment, were divided into four equal groups, i.e. 20 teeth. The maxillary first premolars of all subjects were loaded with either light (25 g) or heavy (225 g) orthodontic force on both the left and right side. After 4 weeks of orthodontic force loading, the upper left first premolars were extracted and served as the positive controls whilst the upper right first premolars were placed in retention for either 4 or 8 weeks before extraction and served as the experimental group. The extracted teeth from all groups were investigated using micro-computed tomography. The volumetric changes of resorption craters were measured using specially designed computer software to depict cementum repair.
RESULT: (1) Eight weeks of passive retention following 4 weeks of light orthodontic force application resulted in a lower volume of root resorption than 4 weeks of passive retention following 4 weeks of heavy orthodontic forces ($P < 0.05$). (2) The total amount of cementum repaired was not affected by orthodontic force magnitude and/or retention time ($P > 0.05$), indicating a concurrence of resorption and repair during passive retention. (3) The majority of the reparative process seemed to have occurred before 4 weeks of passive retention following the application of 4 weeks of light orthodontic forces. (4) There was wide individual variation in the amount of cementum repair following orthodontic force application.
CONCLUSION: Light orthodontic forces with a longer retention period provides more favourable cementum repair than heavy orthodontic forces with a shorter period of retention.

20 BIOFILM FORMATION ON SURFACE CHARACTERIZED MICRO-IMPLANTS FOR SKELETAL ANCHORAGE

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AIM: The clinical application of metallic micro-implants to effect skeletal anchorage has yielded promising results. However, biofilm formation on their surfaces and subsequent peri-implant tissue infection invariably lead to either exfoliation or surgical explantation of these devices. The present study aimed to assess biofilm formation on five commercially available, surface characterized micro-implant systems *in vitro*.
MATERIALS AND METHOD: Surface analyses were carried out using X-ray photoelectron spectroscopy to determine elemental surface composition, atomic force microscopy to characterize surface roughness, and scanning electron microscopy to evaluate surface topography. Overnight biofilms were grown on micro-implant surfaces by immersion in pooled human whole saliva. The *in situ* biofilms were treated with a 0.2 per cent chlorhexidine digluconate (CHX) or 0.055 per cent sodium fluoride (NaF) containing mouthrinse, respectively, dispersed, and stained with live/dead stain after which bacteria were enumerated using fluorescence microscopy.
RESULTS: High carbon contamination was detected on the metal oxide surfaces, along with traces of inorganic elements (Ca, Cu, Cr, Pb, Zn, and P) which disappeared after Ar+ ion sputtering. The determined surface compositions of these micro-implants deviated markedly from their bulk compositions. Sterilization procedures altered the surface chemistry, as demonstrated by increased carbon load and decreased oxygen content on several implant surfaces. The mean surface roughness (Ra) was around 182 and 69 nm for titanium and stainless steel micro-implants, respectively. Structural defects in the form of protrusions and pittings on a typical machined surface were also evidenced. Biofilms on all micro-implant systems evaluated contained, on average, 57.0 ± 4.5 per cent viable organisms. CHX and NaF mouthrinses demonstrated significant ($P < 0.05$) and comparable ($P > 0.05$) antimicrobial/anti-plaque properties on these biofilms, achieving a mean reduction of 80 per cent in biofilm viability compared with the control.
CONCLUSIONS: Comparison of different implant systems using multiple linear regression analysis indicated that biofilm formation was governed by roughness of the implant surface and the prevalence of carbon- and oxygen-rich components. CHX and NaF mouthrinses appear as a valid part of the oral health care regimen of orthodontic patients treated with these micro-implant systems.

21 OSTEOCLASTOGENIC POTENTIAL OF MONONUCLEAR CELLS BEFORE AND DURING ORTHODONTIC TREATMENT

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AIM: To compare osteoclast (OC) formation and the role of T cells in osteoclastogenesis in periodontal patients (Pp), before and during orthodontic treatment (Ppo). The hypothesis that cytokines overexpressed in T cells from Pp may be

significantly reduced in T cells isolated from the same Pp after orthodontic treatment was tested. To assess the potential regulatory role of T cells in osteoclastogenesis of Pp and Ppo, T cell-depleted PBMC cultures in the presence or absence of MCSF and RANKL was established
MATERIALS AND METHOD: An *in vitro* model consisting of unstimulated and unfractionated peripheral blood mononuclear cells (PBMCs) from untreated Pp and healthy controls were used to study OC formation. The expression of receptor activator of nuclear factor NF-kB (RANKL) and tumour necrosis factor α (TNFα) was analyzed by RT-PCR and western blot in fresh T cell isolated from Pp and healthy controls. Antibodies, anti-RANKL and anti-TNFα, were used to study osteoclastogenesis in PBMC cultures from Ppo.
RESULTS: In unfractionated PBMCs from untreated Pp, the OCs spontaneously developed in a T cell-dependent way. The addition of macrophage colony stimulating factor (M-CSF) and RANKL was necessary to promote osteoclast genesis in T cell-depleted PBMC cultures from Pp, and in unfractionated PBMCs from controls. Freshly isolated T cells from PBMCs of Pp over expressed RANKL and TNFα functional anti-RANKL and TNFα antibodies significantly inhibited osteoclast genesis. In unfractionated PBMCs from PPo the OC formation was reduced by approximately 38.5 per cent ($P < 0.001$) and the RANKL and TNFα expression were significantly reduced at mRNA and protein levels. Numerous large TRAP + OCs were identified in the unstimulated and unfractionated PBMC cultures from Pp (OC average number/well 59 ± 3), whereas a smaller number of OCs appeared in the PBMC cultures from the Ppo (37 ± 4) and even fewer in OCs in the controls (5 ± 2; $P < 0.001$). The addition of M-CSF and RANKL to PBMC cultures from Pp did not significantly change OC number (70 ± 8). Few small-sized OCs developed (10 ± 2) in unstimulated T cell-depleted PBMCs. The addition of M-CSF and RANKL to these cultures induced formation of large TRAP+ OCs (68 ± 5; $P< 0.001$ versus unstimulated T cell-depleted PBMCs).
CONCLUSION: Periodontally compromised patients starting orthodontics after periodontal treatment show a significantly reduced spontaneous OC formation.

22 HEMIFACIAL MICROSOMIA – STABILITY OR RELAPSE: A LONG-TERM FOLLOW-UP**

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AIM: To evaluate the stability of multidisciplinary treatment in a group of patients with hemifacial microsomia treated during the last decade.
SUBJECTS AND METHOD: Twenty-four children with a mean age of 6.5 years. All were treated in Marienhospital, Stuttgart, with distraction osteogenesis (DO) and functional appliances during 1993-2003. Panoramic, lateral and postero-anterior cephalometric radiographs and study models were obtained pre-treatment and 6 months and 1 and 5 years after the surgical procedure. All children underwent orthodontic treatment with the same type of functional appliance. The length of both mandibular ascending rami, the angle between the orbital plane and the maxillary plane, the cant of the occlusal plane, the angle between the hemi-mandibles and the distance between the mesio-buccal cusp of the lower molars and lower arch length were evaluated in order to quantify the treatment outcome.
RESULTS: The surgical treatment remained stable 6 months and 1 year after the end of DO, the height of the distracted ascending ramus was maintained; as well as the above parameters. Five years after the end of treatment there was a significant return to the initial cant of the occlusal plane in 76 per cent of the patients, with a remarkable decrease in the height of the affected side, an increase in the cant of the occlusal plane together with the angle between the hemi-mandibles, a decrease in the arch length on the affected side and a decrease in inter-molar distance. The results suggest a return to the initial growth pattern in most of the hemifacial microsomia cases.
CONCLUSIONS: Even if hemifacial microsomia relapses after combined surgical-orthodontic treatment it is important to improve quality of life and appearance. Treatment is important but the parents must be informed about the probable post-operative changes in order to have good co-operation and long-time positive results.

23 BONE DENSITY AROUND TITANIUM MINIPLATES USED FOR ORTHODONTIC ANCHORAGE IN DOGS

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AIMS: To analyse bone mineral density (BMD) around 80 orthodontic miniplates in dogs and to study the influence of load, in order to define the conditions underlying their anchorage efficiency.
MATERIALS AND METHOD: Two miniplates (Bollard, Surgi-Tec, Belgium) were inserted with two titanium screws per plate, in each quadrant of 10 dogs. Two weeks later, coil springs generating a force of 125 cN were fixed between the miniplates in one upper quadrant of each dog and between those of the contralateral lower quadrant. The other anchors remained unloaded. The miniplates were brushed and checked four times a week to assess stability. The dogs were sacrificed

7 (short-term group, ST) or 29 (long-term group, LT) weeks after surgery. Jaw samples were dissected, dehydrated, embedded and scanned with peripheral quantitative computed tomography (pQCT) in order to measure BMD around the screws. Survival functions and BMD values were statistically analyzed (log-rank, paired and independent *t*-tests, significance at $P < 0.05$).
RESULTS: Successful anchorage was achieved in 53 per cent of miniplates and was significantly higher for maxillary (70%) than mandibular (38%) anchors, but was not affected by loading. Failure occurred 4.9 ± 2.8 (mean ± SD) weeks after surgery. pQCT showed that 62 per cent of the screws presented bone-screw contact and that bone contact must be obtained around both screws to achieve implant stability. BMD was higher around the mandibular than maxillary implants. BMD was higher in LT than in ST dogs, particularly in the mandible. No significant difference in BMD was found between the loaded and the control screws in any of the groups for either maxilla or mandible, nor between opposite sides regarding the direction of load, although BMD measurements tended to be higher in pressure compared with tension zones.
CONCLUSION: Anchorage success rate is not significantly influenced by the load, but is higher in the maxilla than in the mandible, in spite of higher mandibular bone density. Load direction has no significant effect on BMD at the bone implant interface. The first weeks of loading, corresponding to the transition between primary and secondary stability, are the most critical. Stability of titanium orthodontic miniplates depends on rigorous hygiene conditions, as well as on anatomical features of the receptor site, such as the amount of attached gingiva and bone architecture.

24 THE USE OF MINISCREWS IN ORTHODONTICS: A REVIEW OF THE LITERATURE

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AIM: To review the literature on patient-, implant- and surgery-related effects on the stability of miniscrews.
MATERIALS AND METHOD: Investigations published until the end of November 2006 either in English or German were included in a Medline search. Only publications designated as human clinical trials were considered. A minimum of 30 implants were to be used. Patient gender and age, location and procedure of implantation, implant length and diameter, time and amount of loading and possible clinical complications were to be described.
RESULTS: Nine clinical trials covered a total of 294 patients and 693 implants. The mean overall success rate was 83.2 ± 12 per cent. Neither patient gender nor age showed significant effects. In terms of implant design, Miyawaki *et al*. (2003) reported success rates of the smallest screw (diameter: 1 mm, length: 6 mm) to be significantly lower than those of larger ones (0 versus 84 and 85%). Chen *et al*. (2006) reported similar findings for 6 versus 8 mm screws (72 versus 90%). Opposing results were found for implantation protocol: Miyawaki *et al*. (2003) reported higher success using a flapless method (85 versus 75%); Herman *et al*. (2006) applied a flap with considerably better results (100 versus 49%). Screws were distributed between the maxilla (301 screws) and mandible (231 screws). The success rates for screws inserted in the maxilla were significantly higher than in the mandible (Chen *et al*., 2004; Park *et al*., 2006) but overall differed only slightly (86.5 ± 14 versus 83 ± 3.6%). Load-related factors did not play a significant role in the success rate. Healing periods of 2 to 4 weeks and loading of up to 400 cN proved to be acceptable.
CONCLUSIONS: In all the papers analyzed, the success rates were described as being sufficient for effective orthodontic treatment. A small diameter screw design should be avoided; although it minimizes the risk of root damage during insertion, diminished stability and life span are to be expected. There was a marked variation in implantation protocols. The time and amount of loading showed no significant effect on screw stability.

25 TREATMENT PLANNING WITH INTEGRATED DIGITAL MODELS AND CONE BEAM TOMOGRAPHY

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AIM: Cone beam computerized tomography (CBCT) and the shift from traditional plaster casts to digital study models have given the orthodontist two new tools for treatment planning. Digital models allow a more accurate and standardized way of performing measurements on the study casts, as well as providing the ability to superimpose pre- and post-treatment models to visualize the tooth movements which have occurred during orthodontic treatment. CBCT allows the orthodontist to examine the patient's anatomy in three dimensions without the two-dimensional distortion bias inherent in cephalometric and panoramic images. However, the scattering caused by restorations and the low resolution related to the low radiation dose make cone beam reconstructions unfit for simulation of occlusion. The aim of this study was to assess the feasibility of combining CBCT data with digital models in order to obtain an image modality, which allows three-dimensional (3D) visualization of the teeth and skeletal structures, while offering the possibility of simulating orthodontic treatment and/or maxillofacial surgery.

MATERIALS AND METHOD: Pre-treatment digital models including roots (O3DM PRO®) and the CBCT datasets (NewTom™) of the same patients were available. The digital models allowed for segmentation of teeth with roots and surrounding tissues. The widths and lengths of the individual roots had been obtained from the respective CBCT datasets. The data files of the digital models were translated into STL format and, together with the CBCT datasets, imported in special 3D visualization software (Mimics v.10). Point registration was used to align the STL files of the teeth and the gingivae with the CBCT datasets.
RESULTS: Visualization was carried out in both transparent and opaque display modes. The former clearly showed where the roots were located relative to the bony structures. Roots situated close to the surface of the bone or those which had fenestrated the bone were best appreciated in the latter display mode. The proximity of the roots to the outer surface of the jaw may influence the treatment plan for a given patient.
CONCLUSIONS: Combining digital study models with 3D CBCT datasets enables the orthodontist to simulate the treatment goal and judge whether the necessary tooth movements are feasible with regard to the bony support. The combination of digital models and CBCT images may replace plaster study models.

26 EVALUATION OF CONTINUOUS VERSUS INTERMITTENT FORCES ON ROOT RESORPTION

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AIM: Ambiguity still exists as to whether continuous or intermittent forces produce more root resorption. This prospective randomized clinical trial was designed to compare the root resorption generated by continuous and intermittent orthodontic forces.
MATERIALS AND METHOD: Sixteen upper first premolar teeth from eight patients who required bilateral removal of these teeth as part of their planned orthodontic treatment. In each subject, a fixed experimental appliance was placed on the maxillary teeth on both sides, allowing a buccally directed force. The force was generated by a segmental wire made from ß-titanium molybdenum alloy (TMA®). The first premolar on one side received a buccally directed continuous force and the contralateral premolar an intermittent force. The force magnitude for both sides was 225 cN. After 14 days initial activation, an operator controlled the intermittent force with a three day rest period followed by a four day activation period. At the end of the 8 week experimental period the right and left premolars were extracted under strict protocol to avoid root surface damage and analysed using a micro-computed tomographic scan system (SkyScan-1172, Belgium) and specially designed software for direct volumetric measurements (CHULL2D).
RESULTS: It was found that intermittent forces produced less root resorption than continuous force ($P < 0.05$). Analysis by position showed the buccal-cervical region had significantly higher amounts of root resorption than the other areas ($P < 0.001$), corresponding to a region of compression generated by a tipping.
CONCLUSION: Compared with continuous forces, intermittent orthodontic activation, as used in this study, causes less root resorption. This regimen of force, however, may compromise the clinical efficiency of tooth movement.

27 LONG-TERM EFFECTS OF QUADHELIX/CRIB THERAPY ON DENTOSKELETAL OPEN BITES

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AIM: To investigate the effects of a quadhelix/crib (QH/C) appliance in subjects with thumb-sucking habits and a dento-skeletal open bite 2 years after the end of active treatment.
SUBJECTS AND METHOD: Twenty-one subjects treated with the QH/C appliance were compared with a control group of 21 untreated subjects with similar vertical relationships. Lateral cephalograms were analyzed before treatment (T1; mean age 8.4 ± 1.4 years) and approximately 2 years after treatment (T2; mean age 11.7 ± 1.9 years). The mean duration of treatment was 1.5 years ± 7 months. Cephalometric software (Viewbox, version 3.0, dHAL Software, Kifissia, Greece) was used for a customized digitization which included 78 landmarks and four fiducial markers. This program allowed analysis of cephalometric data and superimposition among serial cephalograms. Lateral cephalograms for each patient at T1 and T2 were digitized, and 50 variables were generated for each film. The magnification factor of the cephalograms was standardized at 8 per cent. The T1-T2 changes in the two groups were compared directly by means of a non-parametric test for independent samples (Mann-Whitney *U* test) ($P < 0.05$).
RESULTS: For the vertical measurements, the treated group exhibited a greater downward rotation of the palatal plane when compared with the control group (1.8°). This modification was associated with a significant reduction in the palatal plane-mandibular plane angle (–2.5°) in the QH/C group compared with the controls. At T2 the treated group showed a significantly greater increase in overbite (2.7 mm more than the controls) that was associated with a significantly greater opening of the interincisal angle (5.4° more than the controls). Both the upper and lower incisors exhibited significantly

greater extrusion (1.3 mm) in the Q-H/C group when compared with the controls. The upper lip showed a significant tendency towards retraction relative to the E plane in the treated group with respect to controls (3.6 mm).
CONCLUSIONS: The Q-H/C appliance was effective in correcting the dentoskeletal open bites in 85 per cent of growing subjects with thumb-sucking habits. Correction of the anterior open bite was associated with a clinically significant improvement in the intermaxillary vertical skeletal relationship.

28 CROSSTALK BETWEEN NOTCH1 AND NF-KB SIGNALLING IN OSTEOCLAST DIFFERENTIATION

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AIM: Notch proteins play a fundamental role in the fate of a cell. However, little is known about the role of notch signalling in osteoclast activity. It is also unclear whether notch regulates osteoclastogenesis via the signalling of NF-kB, which is involved in osteoclast differentiation and induced by the receptor activator of its ligand RANKL. The aim of this study was to investigate the crosstalk between Notch1 and NF-kB signalling in osteoclastogenesis.
MATERIALS AND METHOD: Mouse pre-osteoclast cell line RAW264.7 was used. Stable integration of mutant IkBa and Notch1 genes was achieved by retroviral transfection with pRetro-on-IkBa and MSCV-IRES-EGFP-Notch1, respectively. siRNA-Notch1 and wild type construct of pCMV-Tag2-IkBa transfections were carried out with Lipofectamine 2000. Real time PCR and Western blotting were used for the mRNA and protein expressions of the target genes. The involvement of NF-kB in post activation/inactivation of Notch1 was evaluated by electrophoretic mobility shift assay. Interactions of IkBa and Notch1 proteins were demonstrated by co-immunoprecipitation. Recruitment of IkBa protein to the promoter region of Notch1 target gene was tested by chromatin-immunoprecipitation assays.
RESULTS: NF-kB expression was up-regulated by Notch1 activation in RAW264.7 cells which differentiated into osteoclasts. Notch1 activation increased NF-kB DNA binding activity. Supershift analysis with antibodies specific for each NF-kB family member identified the NF-kB complexes as p50. Blocking Notch1 signalling inhibited NF-kB activation. siRNA transfection inhibited NF-kB binding and blocked the formation of nuclear NF-kB complex, which supershifted with antibodies against p50. The cytosolic and nuclear fractions showed decreased nuclear p50 in cells treated with siRNA-Notch1. Furthermore cytosolic sequestering of NF-kB by mutant IkBa up-regulated hes1 expression. These results strongly suggest that IkBa was involved in repressing hes1 gene and RANKL treatment resulted in a temporary release of IkBa from the hes1 promoter.
CONCLUSIONS: Notch1 activation stimulated osteoclastogenesis, including degradation of IkBa and nuclear translocation of p50. In turn, inhibition of NF-kB signalling significantly increased Notch1 expression, with hes1 gene as one of its direct targets. This study showed, for the first time, that a complicated crosstalk between Notch1 and NF-kB is involved in osteoclast differentiation.

29 DENTAL MATURITY RELATED TO VERTICAL DYSPLASIA

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AIM: To compare the timing of dental maturation in children with long and short faces.
MATERIALS AND METHOD: Lateral cephalometric and panoramic radiographs of 360 healthy Turkish children (196 girls, 164 boys) aged between 8 and 16 years were evaluated. Subject selection was based on the lower to total anterior facial height ratio. Subjects with an ANS-Me/N-Me ratio lower or equal to 53 per cent were ranked as 'short faced', whereas those with ratios higher or equal to 58 per cent were categorized as 'long faced'. Each subject's panoramic radiograph was scored according to the criteria of Demirjian *et al*. (1973). Determination of the maturity score and dental age of each individual was carried out according to the revised French-Canadian data (Demirjian *et al*., 1976).
RESULTS: Comparison of the median maturity curves revealed that children with long faces were consistently earlier in dental development. One-way ANCOVA showed that long faced subjects, on average, exhibited a statistically significant advancement in dental age compared with their short faced peers at a certain age in both genders ($P < 0.01$). The mean age for the long face group was 8 months for girls and 5.5 months for boys for the entire age range. Further comparison in two-year age cohorts showed that the differences in dental maturational between the two extreme groups peaked (7 months to 1 year) in the middle age groups (10-14 years), while in the first (8-10 years) and last (14-16 years) age cohorts no statistically significant inter-groups differences were detected in either gender.
CONCLUSIONS: There is a strong trend towards earlier root development of the later-forming permanent mandibular teeth in subjects with a long face compared with those with a short face.

30 EVALUATION OF NON-COMPLIANCE OPEN BITE TREATMENT WITH ZYGOMATIC ANCHORAGE

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AIM: To evaluate the dentoalveolar and skeletal effects of a new generation open bite appliance.
SUBJECTS AND METHOD: Eleven patients (mean age 19.5 years) who underwent intrusion of the posterior dentoalveolar segment using an open bite appliance supported by bilateral zygomatic implants. The study utilized lateral cephalograms of the subjects taken before treatment and after intrusion. The mean intrusion time was 9.6 months.
RESULTS: The mean intrusion, measured as the distance of U6 to the palatal plane, was 3.6 ± 1.4 mm ($P < 0.001$). This resulted in an average of 3.0 ± 1.5 degrees of closure of the Go-Gn-SN angle ($P < 0.001$). The gain in overbite was 5.1 ± 2.0 mm ($P < 0.001$) and the overjet was reduced by 1.4 ± 1.5 mm ($P < 0.01$). The occlusal plane angle changed by an average of 2.4 ± 1.4 degrees counterclockwise rotation ($P < 0.001$). Lower face height was also decreased significantly, by 2.9 ± 1.3 mm ($P < 0.001$). No significant changes were observed in SNA or incisor positions ($P > 0.05$), although the interincisal angle increased by 3.5 degrees ($P < 0.05$).
CONCLUSIONS: Within the limitations of this study, it was demonstrated that zygomatic anchorage can be used effectively for open bite correction through posterior dentoalveolar intrusion. However, further long-term clinical studies with larger samples are required to prove the effectiveness of the technique and the stability of molar intrusion.

31 A COMPARATIVE ASSESSMENT OF ONE-, TWO- AND THREE-STEP ADHESIVE SYSTEMS

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AIM: One- and two-component adhesives are available for bracket bonding which could potentially diminish the possibility of contamination during bonding and result in a saving of chairside time. The aim of the present study was to compare the shear bond strength (SBS) and Adhesive Remnant Index (ARI) scores of 1-, 2-, and 3-component adhesives after thermocycling.
MATERIALS AND METHOD: A total of 100 stainless steel brackets (20 per adhesive group) were bonded to extracted human third molars using five adhesives: Group 1: 1-component adhesive RelyX Unicem (3M Espe, Seefeld, Germany); Group 2: 1-component adhesive Maxcem (Kerr, Orange, California, USA); Group 3: self-conditioning 2-component adhesive system Multilink (Ivoclar-Vivadent, Schaan, Lichtenstein); Group 4: 2-component adhesive system Transbond Plus primer (self-etching) and Transbond XT adhesive (3M Unitek, Monrovia, USA); and Group 5 (control group): conventional 3-component adhesive system consisting of an etchant, Transbond XT primer and XT adhesive (3M Unitek). All samples were exposed to thermocycling (6000 × 5/55˚C) in a mastication device before SBS testing and ARI evaluation. Statistical evaluation was undertaken using the Mann-Whitney *U*-test.
RESULTS: There were no significant differences in SBS between the 2- and 3-component adhesive systems. A significant decrease in SBS was observed using 1-component adhesives, RelyX Unicem or Maxcem, in comparison with the 2- and 3-component systems. ARI scores indicated no significant differences between the groups.
CONCLUSIONS: By enhancing SBS, one-component adhesives have the potential to compete successfully with two- or three-component adhesives.

32 CRANIOFACIAL DEVELOPMENT IN JUVENILE IDIOPATHIC ARTHRITIS: A 28-YEAR FOLLOW-UP

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AIM: To evaluate craniofacial development in juvenile idiopathic arthritis (JIA) patients 28 years after the initial examination at 8 years of age.
SUBJECTS AND METHOD: The original material included 103 patients diagnosed with JIA and examined for the first time between 1976 and 1979. Of these 103 patients, 26 (20 girls, 6 boys) with radiographic temporomandibular joint abnormalities were examined at the mean age of 8.4 years (range 3.9-11.7 years). The disease types at baseline examination were 15 with polyarticular and 11 with pauciarticular JIA. All had active disease in one or more joints. From these 26 patients, 13 were re-examined 25 to 30 years later. The mean age at the last examination was 36.5 years (range 29-40 years). Standardized cephalograms were obtained and analyzed by the digital tracing program Facad®. The data were analyzed by paired *t*-test using the Statistical Package for Social Sciences.
RESULTS: The major finding was that the typical retrognathic mandible at the age of 8 years persisted at 36 years ($P > 0.05$). This was due to a persistent reduction in SNB (76.4°) and a normal SNA (83°). The facial axis decreased from a mean of 90.3 to 86.9 degrees ($P < 0.05$), indicating a posterior growth direction during this period. However, the mandibular plane

angle, being steep at baseline (38°), did not change significantly until 36 years of age and this camouflaged the posterior growth rotation. This may be due to appositional growth at the angles, with the typical notching appearance at the lower mandibular border. The ratio between anterior and posterior face heights did not change in this period. Lower anterior face height increased more than upper face height.
CONCLUSIONS: The average basal craniofacial relationships in this group did not change significantly between 8 and 36 years of age.

33 EFFECTS OF POST-TREATMENT SKELETAL MATURITY ON INCISOR ALIGNMENT RELAPSE

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AIM: To test the hypothesis that relapse of incisor alignment is associated with skeletal maturity at the end of treatment, as assessed by the cervical vertebral maturation (CVM) method.
MATERIALS AND METHOD: This was a case-control study using the post-retention database at the University of Washington. Mandibular incisor irregularity (II) at least 10 years out of retention (T3) was used to define cases (II >6 mm, relapse group) and controls (II <3.5 mm, stable group). The following model measurements were performed: II pre-treatment (T1), II post-treatment (T2), intercanine width (3-3) pre-treatment (T1) and post-treatment (T2). On cephalograms taken at T2 the CVM status was determined. Logistic regression analyses were used to determine the association between relapse and CVM status at T2. The models were adjusted for potentially confounding variables (II pre- and post-treatment, intercanine width change during treatment, gender, age at T2, treatment alternative).
RESULTS: No association between CVM stage at T2 and relapse was demonstrated ($P = 0.89$). Both relapse and stable groups showed a similar distribution of CVM stages ($P > 0.05$). Pre-treatment II and post-retention time were found to be correlated with long-term incisor stability ($P = 0.007$ and 0.034, respectively). Gender was not related to relapse ($P = 0.33$).
CONCLUSIONS: Maturity of craniofacial structures at the end of treatment, as evaluated with the CVM method, does not appear to be associated with long-term stability of incisor alignment.

34 OVER-ERUPTION OF UNOPPOSED MOLARS IN YOUNG AND ADULT RATS

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AIM: There are indications that over-eruption of unopposed teeth is different between young and adult individuals. However, no systematic study has been performed to test if the over-eruption potential is greater in younger individuals than in adults. The aim of this study was to investigate the pattern of unopposed mandibular molar over-eruption in young and adult rats.
MATERIALS AND METHOD: In 15 young (4-week old) and 15 adult (26-week old) male Wistar rats, the right maxillary molar crowns were reduced occlusally, by grinding under anaesthesia. Thirty male rats matched for age were used as the controls. After 4 weeks, the 60 animals were sacrificed and scanned by micro-computed tomography (SkyScan 1072, Belgium). Three-dimensional reconstruction was performed and an open-source imaging platform (Osirix) was used for morphological analyses. First mandibular molar supraposition was estimated by measuring the distance between the centre of the mandibular canal and buccal and lingual cusps on six standardized frontal sections. In these sections the buccal and lingual alveolar bone level of the mandibular first molar was also measured with reference to the centre of the mandibular canal. The left mandibular molar and alveolar bone height were used as the intra-individual control.
RESULTS: During the four week period, the unopposed molars of the young animals extruded an average of 250 μm (±76 μm) more than the molars with antagonists ($P < 0.01$). The alveolar bone level was significantly increased with molar extrusion ($P < 0.01$). In the adult animals the unopposed molars extruded an average of 101 μm (±117 μm) more than molars with antagonist, which was less than that found in the young rat group ($P < 0.01$). The alveolar bone level was not influenced by molar over-eruption in adults.
CONCLUSIONS: In young animals the over-eruption of unopposed molars was greater than that measured in adults. Similarly, the alveolar bone level followed the over-erupted molars of the young animals, but this was not the case for the adult rats.

35 QUANTITATIVE EVALUATION OF PALATAL BONE THICKNESS WITH CONE BEAM COMPUTED TOMOGRAPHY

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AIM: To evaluate the three-dimensional thickness of the palate for miniscrew insertion.
MATERIALS AND METHOD: Randomly selected digital volumetric tomographs of 162 (80 males, 82 females) healthy subjects with an age range of 10 to 44 years, divided into three subgroups: 52 (28 males, 24 females) subjects with an age range from 10 to 15 years, 38 (18 males, 20 females) subjects aged from 15 to 20 years and 72 subjects (34 males, 38 females) between 20 and 44 years of age. Ninety degree paracoronal views of the palate region were reconstructed at 4, 8, 16 and 24 mm posterior to the incisive foramen, and measurements of bone height were made in each reconstruction at 0, 3, and 6 mm increments laterally from the midline in order to describe the palate. The measurements of palatal height in the 162 patients were carried out by two different investigators. The method error was calculated according to Dahlberg's formula ($S2= \Sigma d2/2n$) and the systematic error with a Student's *t*-test. The results were compared using the Kruskal-Wallis test.
RESULTS: The thickest part of the palate was 6 mm to the left and right of the suture in the anterior part of the palate, 4 mm from the incisive foramen. In the other paracoronal sections, the thickness tended to progressively decrease, but the highest values were always found corresponding to the suture. These data support those already reported in the literature, that the palate is the site of choice for miniscrew insertion. No statistically significant differences were found for gender or right and left sides of the palate.
CONCLUSIONS: The thickest part of the palate is the anterior part, but posteriorly the bone is also suitable for the insertion of screws of appropriate thickness and length.

36 'THAT'S ONE SMALL STEP IN EVIDENCE, ONE GIANT LEAP IN TECHNICAL DEVELOPMENT'

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AIM: To systematically analyse orthodontics in a health care perspective and to address the following issues: What risks or consequences does orthodontic treatment versus lack of orthodontic treatment have? Who initiates or decides on treatment? What devices (e.g., indices) are there to assess treatment need? Is the outcome of orthodontic treatment long lasting? Risks and complications?
MATERIALS AND METHOD: Small groups, working together with an information specialist, sought literature interactively in the Medline database from 1966 onwards. The Medline search was supplemented with relevant articles identified from reference lists.
RESULTS: More than 700 articles were identified as being relevant to the issues addressed in this study. Only two articles were graded as having a high level of evidence and 88 as having a medium-high level of evidence. More than 600 articles were excluded due to being of low value. The highest evidentiary value assigned to an issue was grade 2: moderately strong scientific evidence. Grade 2 should be supported by at least one study with high evidentiary value and two studies with medium evidentiary value. Grade 2 was assigned to two issues regarding risks and complications. All other issues were graded evidence grade 3: limited scientific evidence, insufficient scientific evidence or contradictory scientific evidence.
CONCLUSIONS: This systematic review shows the need for further studies. There are some areas in which the review group found a particularly high need for research. Examples include indications and assessments (decisions) for orthodontic treatment, follow-up of treatment results, the correct timing for orthodontic treatment, analysis of the factors that underlie the variations in practice between different local government organisations, the effect of malocclusion on quality of life, and studies in the field of health economics.

37 FUNCTIONAL ADAPTATION AFTER ORTHOGNATHIC SURGERY – TRANSCRIPTION OF MARKER GENES

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AIM: Functional adaptation after orthognathic surgery is necessary to prevent relapse and dysfunction. A temporary or permanent change of the expression of different genes and mRNA for the myosin heavy-chain (MyHC) as well as a mutation of the muscle fibre type composition can be expected. However, some patients show no improvement in jaw position, or relapse following treatment. The aim of this study was to determine the functional status of human masseter muscle before and six month after surgery on the basis of the relative expression of four marker genes and MyHC mRNA isoforms (I, IIa and IIx).
MATERIALS AND METHOD: This was a prospective study involving 32 orthognathic patients, with either prognathic or retrognathic mandibles (mean age 23.5 years). Two hundred and fifty six masseter muscle biopsies were obtained pre-surgically and six months after orthognathic surgery from the anterior and posterior parts on both sides of the mandible. The regulation of the specific genes for functional changes, mechano growth factor (MGF) and myostatin (MyS) both signal contrary effects and the quotient of myogenin (MyoG) and Myo D in connection with MyHC isoforms were performed

by real-time PCR to quantify the up and down regulation before and after surgery and under masticatory stimulation (by chewing gum). Occlusal contacts were measured on plaster casts.
RESULTS: Six months post-surgery MGF was 2.1 times upregulated and MyS was 0.8 times down regulated which provide evidence for functional adaptation. The MyoG/MyoD ratio decreased in patients with masticatory stimulation more than those without. This stimulation effect correlated with a shift of MyHC fibre isoforms in the direction of type II (fast twitch) fibres. This shift corresponded further with the number of teeth in occlusion (35% before and 68% after surgery) and suggests a change in muscle quality. An increase in the number of fast twitch fibres (IIa) indicates a higher muscle force.
CONCLUSION: Measurement of expression of the four marker genes provides real information about the functional status and changes in masseter muscle before and after osteotomy. The stability of the results of orthognathic surgery depends on optimal sagittal and vertical jaw positions, maximum interdigitation of the occlusion and fast physiotherapeutic rehabilitation/training.

38 SKELETAL EFFECT OF ORTHOPAEDIC HEADGEAR THERAPY: FACT OR FICTION?
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AIM: To analyze the strain induced in the sutures of the midface and the cranial base when employing headgear therapy involving the application of orthopaedic forces. The question whether the mechanical signal induced in the sutures can sufficiently account for a growth influencing effect was also to be clarified.
MATERIALS AND METHOD: For calculations, a finite element model of the viscero- and neurocranium was used that consisted of 53,555 tetrahedral elements and 97,550 nodes. The strain induced in the sutures of the cranial base and the midface when applying orthopaedic headgear forces of 5 and 10 N was computed and recorded using an interactive measurement tool.
RESULTS: The magnitude and distribution of the measured strain depended on the level and direction of the acting force. Overall, the strain measured at the sutures of the midface and the cranial base was moderate. The measured peak values at a load of 5 N per side were usually just below 20 μstrain irrespective of the force direction. A characteristic distribution of strain values appeared on the anatomical structures of the midface and the cranial base for each vector direction.
CONCLUSION: The signal arriving in the sutures appears to be well below threshold, since the maximum measured strains in most sutures were about 100 fold lower than Frost's threshold (minimum effective strain). A skeletal effect of the orthopaedic headgear due to a mechanical effect on sutural growth cannot be confirmed from the results.

39 CLINICAL EFFECT OF 2 PER CENT CHLORHEXIDINE GLUCONATE AND A PLACEBO ON ORTHODONTIC PATIENTS**
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AIM: To compare the short-term clinical effect of 2 per cent chlorhexidine gluconate gel (CG) and a placebo gel (PG) on orthodontic patients with gingivitis.
SUBJECTS AND METHOD: Fifty patients (31 females, 19 males, 12 to 20 years of age) divided into two equal groups. As determined by the toss of a coin, the first molars on the right or left side of the mouth received either CG or PG. The gingival index (GI) of Löe and Silness, the Papilla Bleeding Index (PBI) of Mühlemann, and probing depth (PD) with a Michigan 0 probe, were recorded at the first permanent molars. These indices were evaluated at baseline and after 2, 4, 8 and 12 weeks in a single blind manner. Student's *t*- and Chi-square tests were used to analyze the data.
RESULT: No differences between the groups were seen at baseline for any of the parameters. PD was significantly reduced in the experimental group as compared with the controls ($P< 0.001$). There was a significant difference in GI and PBI in the experimental group as compared with the control group ($P< 0.001$).
CONCLUSION: The use of CG is effective in reducing gingivitis in adolescent undergoing orthodontic treatment.

40 CYTOTOXICITY AND SHEAR BOND STRENGTH OF FOUR ORTHODONTIC ADHESIVE SYSTEMS
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AIM: To compare the cytotoxicity of four orthodontic bonding systems, three 3-step systems (Light Bond, Enlight, Concise) and one 2-step system with a self-etching primer (Transbond), and to evaluate the shear bond strength (SBS) of these materials in a universal testing machine, Z 010 (Zwick GmbH, Ulm, Germany).

MATERIALS AND METHOD: Brackets were tested in combination with composites and bonding agents and compared with brackets alone. Glass specimens were used as controls in all experiments. One of the 3-step systems was chemically-cured (Concise) and the other systems were light-cured. Specimens were added to the cultures immediately after fabrication or after pre-incubation for 7 days under standard cell culture conditions. They were incubated with L-929 fibroblasts for 72 hours and cells were counted by flow cytometry. SBS testing was conducted with 157 freshly extracted human third molars.
RESULTS: Cytotoxicity of fresh specimens of all light-cured systems (including the self-etching system) was moderate and comparable, whereas the chemically-cured system was significantly more cytotoxic. After 7 days of pre-incubation, all systems were significantly less cytotoxic than fresh specimens ($P < 0.001$). Brackets tested alone were not cytotoxic. The chemically-cured system (Concise 17.87 ± 1.04 MPa) showed the lowest SBS compared with the light-cured systems (Light Bond 23.23 ± 1.53 MPa, Enlight 20.32 ± 1.06 MPa, Transbond 20.39 ± 1.18 MPa).
CONCLUSION: The self-etching orthodontic bonding system had moderate cytotoxicity which was comparable with the 3-step systems; this timesaving technique was not associated with more cytotoxicity. The SBS of the self-etching orthodontic bonding system (Transbond) was comparable with conventional 3-step systems.

41 A 13-YEAR FOLLOW-UP OF HARD AND SOFT TISSUE STABILITY AFTER BILATERAL SAGITTAL SPLIT SETBACK SURGERY

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AIM: To conduct a long-term follow-up study on the stability of hard and soft tissues after bilateral sagittal split osteotomies, with rigid internal fixation, to set back the mandible.
SUBJECTS AND METHOD: Seventeen patients (6 females, 11 males) were re-examined 12.7 years after surgery. Records were also available before surgery and 5 days, 6.6 months, and 14.4 months after surgery. Lateral cephalograms were traced by hand, then digitized and evaluated with the Dentofacial Planner® program. The *x*-axis for the system of co-ordinates ran through Sella (point zero) and the line NSL minus 7 degrees. The program determined the *x*- and *y*-value of each variable and the associated angles and distances.
RESULTS: The mean relapse 12.7 years post-surgery was 0.94 mm (15%) at point B and 1.46 mm (21% of the initial setback) at pogonion. The mean net effect on the labial fold (soft tissue point B) was 101 per cent of the setback at point B, and at soft tissue pogonion it was 82 per cent of the setback at pogonion. The net effect on lower lip (labrale inferior) was 113 per cent of the setback at incision inferior.
CONCLUSION: The long-term results in mandibular setback patients appear to be more stable than in mandibular advancement patients. The initial soft tissue profile, the initial growth direction, and remodelling processes on the hard tissues must be considered as reasons for long-term relapse. Normal growth positively influences the long-term results in females: further distalization of the mandible was observed after 12.7 years.

42 SOCIO-ECONOMIC AND SOCIO-PSYCHOLOGICAL PREDICTORS OF IMPROVEMENT IN OCCLUSION

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AIM: To date, methods to predict improvement in occlusion have focused principally on downstream predictors. The potential impact of upstream predictors has been neglected. The aim of this investigation was to test whether upstream factors such as: problems experienced in daily life, resilience, parental support and socio-economic status can predict improvement in occlusion.
SUBJECTS AND METHOD: A hospital-based longitudinal prospective design was adopted. Patients were consecutively selected from the Orthodontic Clinic. A minimum sample size of 126 patients was proposed and the study included adolescents aged between 12 and 16 years who were due to undergo treatment for the following two malocclusion traits: anterior crossbite and/or anterior upper dental crowding (>2 mm). Baseline data collection was carried out before the placement of fixed appliances. Thereafter, the patients were followed-up for one year to assess initial improvement in occlusion. During this period they were followed on a monthly basis to collect information relating to their daily life. Data analysis was carried out on the 89 subjects who have to-date completed their one year follow-up. Univariate analysis using binary logistic regression was performed between each of the independent variables and initial improvement in occlusion.
RESULTS AND DISCUSSION: The response rate was 98.4 per cent and the drop out was 6.4 per cent. Distal upstream predictors in terms of social class (OR = 0.3; 95% CI = 0.09-0.95; $P = 0.040$) and maternal support (OR = 3.5; 95% CI = 1.44-8.34; $P = 0.006$) showed an important and statistically significant difference in initial improvement in occlusion, whilst more proximal upstream predictors such as daily life (OR = 1; 95% CI = 0.4-2.3; $P = 0.988$) and resilience (OR = 1.7; 95% CI = 0.74-4.06; P = 0.205) failed to reach statistical significance. The findings of this study offer positive evidence to

support the concept that high levels of maternal support and social class are associated with increased adolescent adherence (Cucalon and Smith, 1989; Mehra *et al*., 1998) and a more positive parent- and child-operator relationship (Nanda and Kierl, 1992).
CONCLUSION: Distal upstream predictors, in terms of social class and maternal support, are statistically significant in their ability to predict initial improvement in occlusion. In contrast, no such detectable difference was found in relation to proximal upstream predictors such as daily life and resilience.

43 META-ANALYSIS OF THE EFFICACY OF POWERED TOOTH BRUSHES IN ORTHODONTIC PATIENTS

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AIM: Although powered toothbrushes have been recommended for gingivitis prevention in orthodontic patients, a relevant meta-analysis is lacking. The aim of this meta-analysis was to compare the efficacy of powered and manual toothbrushes in reducing gingival inflammation in individuals undergoing fixed orthodontic appliance therapy.
MATERIALS AND METHOD: Citations to potentially relevant trials published in journals or in the form of dissertations or appearing in conference proceedings were located by searching the appropriate databases. Efforts to identify potentially relevant unpublished or ongoing trials were made by searching the databases of research registers. Trials appropriate to be included in the review should be randomized controlled trials fulfilling certain criteria: (a) study design, (b) participants' characteristics, (c) intervention characteristics and (d) principal outcome measures. The weighted mean difference with the 95 per cent confidence intervals was used to express the comparative treatment effect. The random effects method for meta-analysis was used to combine the treatment effects across studies in each category. Trial quality was evaluated by assessing randomization, allocation concealment, blinding and handling losses.
RESULTS: Five trials were considered appropriate for the meta-analysis. Statistically significant superiority of powered toothbrushes was observed only in one study. Based on quality assessment and the short experimental period of the trials reviewed, current evidence was insufficient to support the comparative efficacy of powered toothbrushes in reducing gingivitis in patients undergoing fixed orthodontic appliance therapy.
CONCLUSION: Any inferences to the clinical practice are precluded. Greater standardization of the methodology employed is warranted in future trials.

44 *IN VIVO* EVALUATION OF TOOTH COLOUR CHANGES ASSOCIATED WITH ORTHODONTIC TREATMENT

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AIM: To prospectively assess colour alterations of natural teeth associated with orthodontic bonding using two different adhesives.
SUBJECTS AND METHOD: Twenty-six consecutive patients treated with fixed appliances bonded with a chemically cured resin (Unite, 3M Unitek, Monrovia, California, USA) or a light-cured resin (Transbond XT, 3M Unitek), using a split-mouth design. The reflectance spectrophotometer SpectroShade™ (MHT Optic Research AG, Zurich, Switzerland) was used for tooth colour assessment *in vivo*. The spectrophotometric data of a standardized circular area on the labial surfaces of teeth were recorded, employing a repeated-measuring design (n = 5), before bracket bonding and at the end of treatment. The CIE colour parameters (L*, a*, b*) were measured for each adhesive and tooth type, and the corresponding colour differences between the interval groups were calculated according to the equation DE= [(DL*)2 + (Da*)2 + (Db*)2]1/2. The effect of these parameters on colour was assessed with a series of one-way repeated measures analyses and their differences using the Bonferroni's comparison test ($P < 0.05$).
RESULTS: Orthodontic bracket bonding and debonding have significant effects on CIE colour parameters of natural teeth, since the L* values (lightness) decreased ($P < 0.001$), whereas a* and b* values (hue and chroma) increased ($P < 0.001$) at the end of treatment. Total colour differences of all tooth types during the two intervals demonstrated significant colour changes, with their mean differences exceeding the range of 2.52 DE-units. The chemically-cured resin exhibited larger colour changes than light-cured composite. The clinical relevance of the colour alterations induced by orthodontic treatment was obtained by comparison of the measured DE values with the standard value of clinical detection (DE = 3.7). It was found that 12.98 per cent of the bonded teeth presented visible, clinically significant colour differences, while 80.76 per cent of patients presented at least one tooth with visible colour change.
CONCLUSIONS: The colour of natural teeth during fixed orthodontic treatment changes to a varying extent. This outcome may be caused by the irreversible nature of microstructural enamel modifications associated with bonding, debonding and

cleaning procedures, the colour stability of adhesive materials, and the low tolerance of colour parameters to induced variations.

45 THREE-DIMENSIONAL VOLUMETRIC CHANGES IN THE FACES OF GROWING CHILDREN

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AIM: To evaluate the three-dimensional (3D) surface and volumetric changes which occur in the faces of growing children.
SUBJECTS AND METHOD: Ninety-five 'normal' looking children were recruited as part of a longitudinal study of facial morphology. The Body Mass Index (BMI) and a history of orthodontic treatment were recorded and evaluated. The facial morphologies of the children were recorded using two high resolution 3D laser cameras (Minolta VI900). The children were positioned in the natural head position and each scan took approximately 2.5 seconds to complete. Five imaging scans were recorded for each individual over a 2-year evaluation period. These images were processed and evaluated using commercially available reverse modelling software, Rapidform 2004, and a macro sub-routine developed in-house.
RESULTS: Eighty-six children remained at the end of the 2 year study period representing a 9.5 per cent drop-out rate. Four hundred and thirty facial scans were obtained and evaluated. The scans were grouped into the following four categories: normal males, normal females, males with treatment, and females with treatment. Average faces were created for each sub-group and the faces were superimposed onto the baseline averages within each subject category. The results showed that were significant yearly increments to the volumes of the brows, nose and mandible and there were yearly reductions in the volumes and surface areas of the cheek region. The largest changes in magnitude were recorded in the mandibular region (648-4832 mm^3) and nose (147-3340 mm^3). There was a general reduction and flattening of the cheek region and the volumes ranged from 400-1000 mm^3. The mean surface changes in each category were compared to determine if there were inter-pair differences between independent proportions (Newcombe, 1998). Only subjects in the non-treatment group were tested as the subject numbers in the other groups were too small for meaningful comparisons. The results of the statistical analysis showed that there was a significant difference during the last time frame between males and females. The results, 0.28 with a 95 per cent confidence between 0.02 and 048, suggested that males exhibited a significantly greater amount of change.
CONCLUSION: Surface and volume changes could be calculated accurately for regions of the face and represent a novel approach using 3D applications for the study of facial growth.

46 PREDICTION OF PERSISTENCE OF PRIMARY MOLARS IN PATIENTS WITH MULTIPLE AGENESIS

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AIM: To create a method for predicting the persistence of primary molars in patients with multiple agenesis.
MATERIALS AND METHOD: Panoramic radiographs from 51 males (agenesis of 5 to 17 teeth) and 54 females (agenesis of 5 to 21 teeth). All subjects (6 years 9 months to 16 years 7 months) had agenesis of one or both lower second premolars. Patients who had been diagnosed with ectodermal dysplasia or craniofacial anomalies were excluded. The radiographs were divided into two groups according to tooth morphology and pattern of agenesis. Group I, morphological symptoms: screwdriver-shaped maxillary central incisors; incisor invaginations or slim incisors; taurodontic molar roots; occurrence of agenesis in regions not normally affected by agenesis. Dentitions classified into group I had at least two of these symptoms. Group II, dentitions without at least two of the above symptoms. The degree of root resorption of the lower second primary molar was analyzed according to a scoring system devised by Haselden *et al*. (2001) and converted to a metric scale for statistical purposes.
RESULTS: Subjects with agenesis of more than seven teeth were classified into group I more frequently than to group II ($P = 0.015$ exact test). There were 8 per cent more females in group I than in group II ($P > 0.3$). Root resorption of the primary molars was more severe in group I than in group II, also when age was considered. The resorption score in group I was, on average, 1.46 higher than in group II ($P < 0.001$)
CONCLUSIONS: A classification of multiple agenesis cases according to characteristics in tooth morphology and pattern of agenesis appears to be useful for predicting the degree of resorption of primary mandibular molars in multiple agenesis cases. Less resorption of primary molars occurs in group I dentitions.

Haselden K, Hobkirk J A, Goodman J R, Jones S P, Hemmings K W 2001 Root resorption in retained canine and molar teeth without permanent successors in patients with severe hypodontia. International Journal of Paediatric Dentistry 11: 171-178

47 ANALYSIS OF THREE-DIMENSIONAL CHANGES IN THE POSITION OF MINSICREWS DURING CLINICAL USE

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AIM: To analyze the three-dimensional (3D) changes in the position of miniscrews during clinical use.
SUBJECTS AND METHOD: Thirteen patients with miniscrews (diameter: 2 mm, length: 12-14 mm) used as anchorage in the maxilla. The miniscrews were inserted in the maxillary zygomatic buttress as direct anchorage for *en masse* retraction of the upper anterior segment. Nickel-titanium closed-coil springs were placed for the retraction 2 weeks after insertion of the miniscrews. Impressions for study casts were taken immediately before force application and 7 months later (or earlier if anterior retraction was complete). The study models were scanned with a 3D scanner and the data were superimposed by the computer program using three reference points.
RESULTS: During 3-7 months of anterior segment retraction, the mean movement of the head of the miniscrew was 0.25 mm buccally, 0.39 mm anteriorly and 0.52 mm inferiorly. These changes were significant. Mean retraction of the anterior segment was 4.36 ± 1.06 mm.
CONCLUSION: Miniscrews provide clinically satisfactory anchorage for anterior segment retraction, but do not remain absolutely stationary throughout orthodontic loading.

48 EFFECT OF SELECTIVE H1 RECEPTOR ANTAGONIST ON TOOTH MOVEMENT IN RATS

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AIM: Orthodontic forces applied to the tooth alter the vascularity and blood flow of the periodontal ligament, resulting in synthesis and release of various chemical mediators in the periodontal tissue. Histamine is one of the most studied chemical molecules in the inflammatory process and is widely distributed in mammalian tissues, however its involvement in orthodontic tooth movement has not been established yet. The aim of the present study was to determine the role of a selective H1 receptor antagonist (letizen) on tooth movement in rats.
MATERIALS AND METHOD: Thirty Wistar rats divided into three equal groups. In group I, a closed coil spring (F = 25 cN) was used and the animals were treated daily with 10 mg/kg body weight of letizen, a selective H1 antagonist. In group II (control), a closed coil spring was also used and the animals were treated daily with a placebo. The coil spring in groups I and II was attached between the upper left first molar and upper left incisor. The distance between the teeth was measured with a digital calliper (accuracy ± 0.01 mm) on days 0, 7, 14, 21, 28, 35 and 42. The differences in the distance between the teeth were calculated to determine the amount of tooth movement. Graph Pad Prism 4.00 and two-way ANOVA were used for statistical analysis.
RESULTS: Tooth movement was significantly less on day 7 in animals in group I ($P < 0.05$) compared with animals in group II, but there was no significant difference in tooth movement between group I and II from day 14 to day 42. In the control group, the distance increased during the duration of the experiment due to natural distal drift of the molars ($P < 0.001$). It therefore appears that the action of histamine as a signalling molecule on H1 receptors plays a significant role only in the initial phase of orthodontic tooth movement which coincides with the phase of acute inflammation of periodontal tissues, while in the later stages of tooth movement it does not seem to have any significant effect.
CONCLUSION: The histamine system could be involved in the mechanism of tooth movement. The selective H1 receptor antagonist, letizen, decreases tooth movement in the initial phase of orthodontic tooth movement in rats.

49 LONG-TERM EFFECTS OF EARLY HEADGEAR TREATMENT ON OCCLUSAL STABILITY AND AESTHETICS

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AIM: To assess the long-term stability of treatment in a group treated with early headgear (HG) and a control group, and also to explore the influence of different treatment modalities on dental aesthetics.
SUBJECTS AND METHOD: Sixty-eight children (40 males, 28 females) aged 7.6 years (SD 0.3). The children were randomly divided into two groups of equal size. In the first group, HG treatment was initiated immediately, while in the control group only minor interceptive procedures were performed during this period. Fixed appliance treatment, if needed, including extraction of permanent teeth due to crowding, was carried out after completion of early treatment. The occlusal changes and the aesthetic outcome of treatment were evaluated after 13 years of follow-up (at 22 years of age) using the Peer Assessment Rating (PAR) Index, Little's Irregularity Index (LII) and the Aesthetic Component of the Index of Orthodontic Treatment Need.

RESULTS: There was a reduction in the PAR index after the second phase of treatment but a worsening at the 13-year follow-up both in the HG and control groups. No differences were found between the HG and control groups either in PAR or LII at any observation period. The patients who had undergone extractions had higher PAR scores, and a greater increase in PAR score, but a lower LII when compared with patients without extractions. Higher LII scores at the start of the study were strongly associated with extractions in the second phase of treatment. Gender was also related to increased PAR and LII scores. No significant differences were found in dental aesthetics between the HG and control group. When aesthetics were evaluated by dental specialists, the occlusion and the upper anterior segment alignment were found to be more important than lower incisor alignment.
CONCLUSIONS: No significant differences were found in treatment outcome between the early HG and control group at a 13 year follow-up. A poorer occlusion (as assessed by the PAR Index) and a greater level of relapse were observed in patients treated with extractions. A higher LII at the outset of treatment was strongly associated with extractions in the second phase of treatment. Males also appeared to show poorer stability than females. Neither treatment modality appeared superior when considering dental aesthetics at the end of treatment, and it seems that treatment timing has no influence on stability.

50 LONG-TERM DEVELOPMENT AFTER CLASS II DIVISION 1 TREATMENT IN ADOLESCENTS AND ADULTS

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AIM: Comparison of long-term post-treatment dentoskeletal development after successful treatment of Class II division 1 malocclusions in adolescents and adults, with and without orthognathic surgery.
SUBJECTS AND METHOD: Cephalograms of subjects with comparable Class II division 1 malocclusions, taken before and after orthodontic treatment, and at least 3 years post-retention (on average 10 years after treatment) were retrospectively compared. The mean age at the start of treatment was 12.3 years for the 49 adolescents, 28.5 years for the 21 adults with only orthodontic treatment, and 26.9 years for the 43 adults with combined surgical-orthodontic treatment.
RESULTS: Mean post-treatment changes were small and the adolescent and surgery groups exhibited larger ranges. *t*-tests showed no significant differences in post-treatment overbite (OB) and overjet (OJ) changes between the groups. The adolescents differed from the adults in vertical and sagittal skeletal changes. The adult surgery group also differed from the non-surgery group, with the non-surgery group showing only small changes. The adolescents and surgical cases showed larger changes which were in opposite direction. There was more eruption of the incisors in adolescents than adults, while the non-surgical adults had more eruption of upper incisors than the surgical group. Correlation analysis showed that OJ changes were related to skeletal changes only in the surgery group. Changes in OB were related to lower face height changes in the surgery and adolescent groups. In all groups, OB and OJ changes were related to changes in the position of the lower incisors. Only in the non-surgical group were OB changes related to changes in the vertical position of the upper incisors. In all groups, ANB changes were related to compensatory changes in the position of the upper incisors. Changes in lower face height were related to compensatory changes in vertical incisor position in the adolescent and surgery groups. Regression analysis showed that OB and OJ changes in the surgery group were primarily associated with skeletal changes, whereas in the other groups the former were related to changes in incisor position.
CONCLUSIONS: All groups showed the same level of stability for OB and OJ correction and some compensatory tooth movement for skeletal changes. OB and OJ changes were related to changes in incisor position and, in the surgical group, these changes were primarily associated with skeletal changes. The adult non-surgical group exhibited few changes.

51 THREE-DIMENSIONAL FORCE-MOMENT MONITORING IN ORTHODONTICS

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AIM: The lack of appropriate tools for three-dimensional (3D) force-moment monitoring in individual teeth resulted in the development of an orthodontic bracket with an integrated microelectromechanical sensor system. Recently, the feasibility of this approach has been successfully demonstrated in an enlarged smart bracket model with wire-mediated data and energy transmission (Lapatki *et al.*, 2007). The first smart bracket with dimensions similar to customary brackets has since been developed.
MATERIALS AND METHOD: A true-scale smart bracket was calibrated in the therapeutic range (±2 N/±20 Nmm) using a 6-degree-of-freedom (6DOF) system for 3D force-moment application and measurement in a three-bracket model. From the calibration data, fit parameters for the 20 stress components provided by the embedded sensor system were calculated. To evaluate measurement accuracy of the smart bracket, a sequence of 524 different load cases was utilized. Applying the calibration fit parameters, the 6 force-moment components were inferred from the sensor signals for each load case and quantitatively compared with those values simultaneously registered by the 6DOF system.

RESULTS: Comparison between the externally applied force-moment components and the corresponding smart bracket values revealed good agreement for the 6 force-moment components except for Fz (labio-lingual direction). The corresponding standard deviations of the differences were <0.07 Nmm for Fx and Fy, and <0.96 Nmm for Mx, My and Mz.
CONCLUSIONS: Smart brackets make it possible to determine (*in vitro*) five of the six force-moment components exerted on individual teeth by fixed appliances with acceptable measurement accuracy. The lower sensitivity of the embedded sensor system for labio-lingually directed forces is related to the minimal stresses generated by this force component in the plane parallel to the surface of the sensor chip. This aspect will be accounted for by redesigning the sensor system. Smart bracket systems may prove useful for biomechanical research as well as for the training of orthodontists in fixed appliance therapy.

Lapatki B G, Bartholomeyczik J, Ruther P, Jonas I E, Paul O 2007 Smart bracket for multi-dimensional force and moment measurement. Journal of Dental Research 86: 73-78

52 PREVALENCE AND GENOTYPES OF *CANDIDA ALBICANS* IN FIXED APPLIANCE PATIENTS

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AIM: To determine the oral prevalence and genotypes of Candida species in patients before and during fixed orthodontic appliance (FOA) therapy.
SUBJECTS AND METHOD: One hundred and twelve consecutive Chinese patients (mean age 17.7 ± 5.8 years) requiring FOA therapy. The dental stage was DS4M1 or later. Ninety-seven subjects (87%) remained in the study after 12 months. Baseline data (T0) of oral carriage of Candida species was obtained prior to appliance insertion by collecting oral rinse samples using a standard technique. FOAs were then inserted and samples were obtained on sequential visits (T1 to T10) over a 12-month period for repeat mycological studies. Consistent candidal carriers were identified. Germ tube test and Analytical Profile Index (API) ID32C yeast identification system (bioMerieux®) were used to speciate the isolates. Random amplification of polymorphic DNA (RAPD), polymerase chain reaction (PCR) and gel electrophoresis were carried out with standard protocol to identify the genotypes of sequential *C. albicans* isolates, using the primer RSD-11 (5' - GCA TAT CAA TAA GCG GAG GAA AAG - 3').
RESULTS: Oral prevalence of candida at T0 was 32 per cent, which is higher than found in previous studies of Chinese (24%). Average candidal carriage rates steadily increased, peaked at T5, levelled out and increased again thereafter. Significant differences in carriage rates were found between T0 versus T5 and T10 respectively ($P < 0.05$). Eleven subjects were consistent candidal carriers from T0 to T10. Ninety-one per cent of all yeasts cultured from the carriers were identified as *C. albicans*. Genotypes of *C. albicans* in the carriers were obtained over a period of 12 months. Similar genotypes of *C. albicans* persisted over time in nine of the carriers with minor variations in RAPD band profiles. Major variations in genotypes were noted in two carriers. Identical genotypes of *C. albicans*. were rarely isolated from different carriers.
CONCLUSIONS: (1) The incidence of candidal carriers increased moderately after FOA insertion. (2) *C. albican* is the most prevalent yeast in consistent candidal carriers. (3) *C. albicans* isolates from consistent candidal carriers of FOA patients demonstrated little genetic 'divergence' over a 12 month period.

53 ORTHODONTIC TREATMENT NEED AND ORAL HEALTH RELATED QUALITY OF LIFE IN YOUNG ADULTS

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AIM: To determine the relationship between orthodontic treatment need and oral health related quality of life (OHRQoL) among young adults.
SUBJECTS AND METHOD: A cross-sectional study involving a consecutive sample of 273 young adults seeking orthodontic care over a two-year period. OHRQoL was assessed using the short form, Oral Health Impact Profile (OHIP-14), and the OHRQoL United Kingdom (UK). Study casts were assessed for orthodontic treatment need using different occlusal indices: Index of Orthodontic Treatment Need (IOTN) Aesthetic Component (ITON-AC) and Dental Health Component (IOTN-DHC); Index of Complexity, Outcome and Treatment Need (ICON) and Dental Aesthetic Index (DAI). Variations in OHIP-14 and OHRQoL-UK were determined with respect to orthodontic treatment need and the magnitude of differences calculated (effect size: ES).
RESULTS: There was a significant, but weak, correlation between occlusal indices scores and OHIP-14 scores ($P < 0.05$, $r < 0.3$) and between occlusal indices scores and OHRQoL-UK scores ($P < 0.05$, $r < 0.4$). The magnitude of the statistical difference in OHRQoL-UK scores was moderate-large (ES > = 0.50), irrespective of which occlusal index was used to

categorise orthodontic treatment need, and was largest for DHC (ES 0.85) and ICON (ES 0.71). The magnitude of the statistical difference in OHIP-14 scores was greatest when DHC and ICON was used to categorize subjects into orthodontic need groups, ES 0.50 and 0.65, respectively.
CONCLUSION: The magnitude of the statistical difference between those with, and without, an orthodontic treatment need was larger when OHRQoL was assessed using OHRQoL-UK, compared with OHIP-14, irrespective of which occlusal indices was used to categorize treatment need. DHC and ICON were more useful indices in identifying greater differences in OHRQoL with respect to orthodontic treatment need compared with DAI and AC.

54 LIGHT EMITTING DIODE VERSUS HALOGEN LIGHT-CURING OF ADHESIVE-PRECOATED ORTHODONTIC BRACKETS

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AIM: A randomised clinical trial to evaluate the performance of adhesive-precoated brackets cured with two different light-curing units [conventional halogen and light emitting diode (LED)].
MATERIALS AND METHOD: A total of 1152 adhesive precoated (APC) stainless steel brackets, bonded to the tooth surfaces of 65 consecutively treated patients. Each patient's mouth was divided into four quadrants. In 34 randomly selected patients the right maxillary and left mandibular quadrants were cured with a halogen light, while the remaining quadrants were treated with the LED curing units. In the other 31 patients, the quadrants were inverted. Five hundred and seventy seven APC brackets were cured with a conventional halogen light for 20 seconds and the other 575 with the LED curing unit for 10 seconds. For each bracket, the bonding date, the operator, the type of light used for curing and the date of any bracket failures over a mean period of 8.9 months were recorded. Chi-square, Yates-corrected chi-square, Fisher's exact tests, and Kaplan-Meier survival estimates and the log-rank test were used to analyse the results.
RESULTS: No statistically significant differences in bond failure rates were found between the APC brackets cured with the halogen light and those cured with a LED curing unit. However, there were significantly fewer bond failures in the maxillary arch (1.667%) than in the mandibular arch (4.348%) for each light-curing technique.
CONCLUSIONS: When using APC brackets, LED curing units with a 10-second curing time produces similar bond strength and bracket-failure rates to the halogen light, which requires a longer curing time.

55 AN *IN VITRO* STUDY TO DETERMINE THE REMINERALISING EFFICACY OF CASEIN PHOSPHOPEPTIDE

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AIM: The remineralising effect of a casein phosphopeptide (CPP) product, Tooth Mousse™ (GC Corporation, Tokyo, Japan), has previously been tested on demineralised lesions in bovine enamel but the presence of erosion was a confounding variable. The aims of this study were: (1) to define the production of carious demineralisation in bovine enamel that excludes erosion and (2) to compare any remineralisation made by CPP and fluoride toothpaste slurries.
MATERIALS AND METHOD: (1): Five bovine upper incisors were sectioned into six and randomly allocated into one of six groups (1-6). Tooth sections were varnished to leave a 5 × 5 mm window and exposed to a demineralising (pH 4.5) for 12(1), 18(2), 24(3), 30(4), 36(5) or 42(6) hours. Sections were imaged with quantitative light induced fluorescence (QLF) prior to demineralisation. Analysis was carried out using QLF V.2.00 software (Inspektor Research Systems, Netherlands). All samples were examined using transverse microradiography (TMR). (2): A further 12 bovine incisors, sectioned into five and varnished, underwent demineralisation as before for 18 hours. One section of each tooth was analysed with TMR. None showed evidence of erosion. The slabs were allocated by structured randomisation into regimen W, X, Y or Z. W distilled water; X artificial saliva, 0.05 ppmF, pH 7.2; Y 10 per cent weight volume (w/v) CPP in artificial saliva 0.05 ppmF; and Z 10 per cent w/v 1000 ppmF NaH_2PO_4 in artificial saliva 0.05 ppmF. Stored in artificial saliva between dippings for 84 days: 10 hours total test time. The 48 sections each had 13 QLF images as above and TMR for one sample per group
RESULTS: (1): Demineralisation measured as ΔF, showed reduced fluorescence for all samples with increasing immersion time ($P < 0.001$). TMR confirmed progressive mineral loss, increased depth and width of subsurface lesions with no surface mineral loss. Groups 1 and 6 showed mean mineral loss of 1479.7 ± 223.8 and 2400.5 ± 739.7vol% μm, respectively with lesion width progressing from 46.9 ± 2.6 μm to 68.8 ± 17.2 μm and depth from 60.4 ± 3.8 μm to 82.4 ± 20.3 μm. (2): Preliminary results suggest increased fluorescence for samples with regimen Y and Z although Y appears to be more effective than Z.
CONCLUSIONS: (1): The production of carious demineralisation with the absence of erosion can be achieved in bovine enamel under specified conditions. (2): On-going work suggests CPP (Tooth Mousse™) is more effective than 1000 ppmF toothpaste in promoting remineralisation of bovine enamel *in vitro*.

56 FORTY-FIVE YEARS OF ORTHODONTICS AND TEMPOROMANDIBULAR DYSFUNCTION – WHERE HAVE WE BEEN AND WHERE ARE WE GOING?

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AIM: To review temporomandibular dysfunction (TMD) relevance to orthodontists; how malocclusion and temporomandibular disc position have been related to TMD; clinical studies investigating TMD pre- and post-orthodontic treatment. To review studies investigating: how functional occlusion and bruxism may relate to TMD; to assess the wider context of TMD: epidemiology and other musculoskeletal diseases and relate this to clinical, occlusal studies.
MATERIALS AND METHOD: A systematic review is not possible when studies have marked variations in their methods. Therefore, study selection was based on the following where possible: as a crude and general rule only, important papers tend to be cited more frequently than others. However, many papers are never cited (for example, 35% of existing papers are not cited in any given year) and citation databases do not count all references e.g. books. Literature searches were carried out using Medline (1966-November 2005) and the Cochrane Database of Systematic Reviews bu, as far as was possible, studies were only included if they had been cited at least once in the literature as confirmed by the Web of Science - Science Citation Index expanded, 1900-1914 to 2005. (Part I mean: 28 citations; Part II mean: 40 citations). Studies pre-1966 were accessed by investigation of the reference lists within the studies identified.
RESULTS: There was a lack of evidence for the theory that occlusal factors cause TMD. Investigation of other aetiological factors were relatively neglected, particularly the need to relate the epidemiological profile to TMD aetiology, as occurs for other musculoskeletal diseases.
CONCLUSIONS: Neither static nor dynamic occlusal factors (including orthodontics) can be said to 'cause' TMD. However, other potential aetiological factors exist which would benefit from more investigation. This, together with improved study designs would help provide a stronger evidence-base for future clinical practice. Poor studies have led to much of the controversy over whether occlusal factors (including orthodontics) cause TMD.

57 THE FAILURE RATE OF IMMEDIATELY LOADED MINI-IMPLANTS: A PROSPECTIVE STUDY

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AIM: To evaluate the failure rate of immediately loaded mini-implants used for orthodontic anchorage.
MATERIALS AND METHOD: One hundred and sixty five mini-implants inserted in 105 patients and immediately loaded with 50 cN superelastic coil springs. Sixty devices were inserted in the maxilla and 105 in the mandible at the following sites: mandibular alveolar process (n = 80), maxillary alveolar process (n = 47), mandibular symphysis (n = 17), retromolar area (n = 10), and palate (n = 11). The mini-implants were used to perform one or more of the following dental movements: incisor intrusion and proclination, incisor retraction, premolar intrusion, midline correction, premolar distal movement, molar uprighting, molar uprighting and mesial movement, molar mesial movement, and molar intrusion. Following 120 days of continuous loading all devices that showed complete absence of mobility were scored as successful, those that showed minimum mobility but stayed in place and could resist further load were scored as partial failures, while those that were lost were scored as failures.
RESULTS: One hundred and forty one mini-implants were successful (85.4%), 15 failed (9.1%) and nine had partial failures (5.5%). The partial failure occurred when the remodelling adjacent to the mini-implant was high. Clinical success was 90.9 per cent, when successful and partial failures were considered together. The maxilla had a greater failure rate (10.0%) than the mandible (8.6%). The palate was the anatomical location with the greatest risk of failure and the mandibular alveolar process showed the lowest failure rate. When evaluating the failure rate it became evident that the following factors were of importance: the insertion procedure, bone quality, mucosal thickness and oral hygiene. Immediate loading, supported by recent histological investigations, was on the other hand not a potential failure risk factor as the overall failure rate was comparable with that found by other authors who performed similar investigations including a healing period before application of the load.
CONCLUSION: Immediate loading of orthodontic mini-implants with light forces should not be considered a risk factor for loss of stability. In a weighted list, incorrect surgical procedure, inflammation and bone and soft tissues characteristics could be considered the determinants of clinical failure.

58 *IN VITRO* ASSESSMENT OF TEMPERATURE RISE IN THE PULP DURING ORTHODONTIC BONDING

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AIM: This *in vitro* study evaluated the temperature changes in the pulp chamber during bracket bonding using four different light sources.

MATERIALS AND METHOD: Eighty intact extracted human maxillary central incisors divided into four equal groups. Brackets (Mini Twin, Dentaurum, Germany) were bonded using Transbond XT (3M/Unitek, Monrovia, California, USA) adhesive and light cured with a low density halogen light for 40 seconds, with a high density halogen light for 40 seconds, with a light emitting diode (LED) for 20 seconds, and with a plasma arc light (PAC) for 6 seconds. The lights were held 5 mm away from tooth surface. A J-type thermocouple wire was positioned in the centre of the pulp chamber. The results were analyzed with analysis of variance (ANOVA) and Tukey HSD tests.
RESULTS: Pulp chamber temperature changes were influenced by the type of light source. All groups showed significant differences between each other (P <0.001). The intrapulpal temperature changes induced by different light sources were: high density halogen (6.84 ± 2.44°C), low density halogen (4.71 ± 0.96°C), LED (2.95 ± 1.12°C), PAC (0.96 ± 0.83°C).
CONCLUSIONS: High and low density halogen light induced significantly higher intrapulpal temperature changes than LED and PAC. Except for high density halogen lights, orthodontic bonding with light-curing units did not exceed the critical 5.5°C value for pulpal health.

59 SURVIVAL RATE OF PALATAL ORTHODONTIC IMPLANTS – A PROSPECTIVE LONGITUDINAL STUDY

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AIM: To assess survival and success of palatal implants placed in the median and paramedian area.
SUBJECTS AND METHOD: Seventy consecutive patients (56 females, 14 males; mean age 25.25 ± 10.58 years, minimum: 10.9 years, maximum: 55.5 years) receiving 72 Orthosystem® (Institut Straumann, Waldenburg, Switzerland) palatal implants from March 1999 to June 2006 were included in this prospective study. One subject was excluded due to a severe wound healing disorder. The orthodontic indications for implant placement were established according to the existing anchorage situation. All palatal implants were placed by the same surgeon (RM) according the Straumann® guidelines for palatal implants. In growing patients the palatal implants were inserted in the paramedian region to avoid possible developmental disturbances of the palatal suture. After a mean healing period of approximately 13 weeks, the palatal implants were directly or indirectly loaded using sectional archwires via rotationally stable suprastructures. After completion of orthodontic treatment the palatal implants were removed by means of a standard trephine (5.5 mm). One patient refused the removal of the palatal implant after successful treatment.
RESULTS: Only three (4.1%) of the 72 implants did not successfully osseointegrate. Two implants were lost due to inadequate primary stability after implant placement. One implant penetrated the incisive foramina and was lost spontaneously. All lost implants were 4 mm in length and had a diameter of 3.3 mm. Two of these implants were replaced after a short healing period and osseointegrated successfully thereafter. Of the 69 successfully osseointegrated implants loaded actively and/or passively for approximately 19 months, only one (1.4 per cent) implant failed after 5 months of unilateral heavy active loading. In 46 cases the treatment was completed and the palatal implants removed. Twenty-three are still being used for orthodontic treatment.
CONCLUSIONS: Orthodontic palatal implants with a rough surface and rotation resistant suprastructure, such as the Orthosystem®, are predictable and reliable tools for a number of treatment options. The survival rate for palatal implants is comparable with, or better than, that of dental implants.

60 FREQUENCY AND CAUSE OF FAILURE OF MINISCREWS FOR ORTHODONTIC ABSOLUTE ANCHORAGE

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AIM: To evaluate the frequency and the cause of failure of miniscrews used as absolute anchorage accessories in orthodontic treatment involving four premolar extractions.
MATERIALS AND METHOD: Seventy-six miniscrews (tomas®, Dentaurum, Germany) inserted in 19 adolescents. All mini-screws were inserted consecutively following the technique described by the manufacturer and were placed in the area between the first molar and second premolar. An individual surgical guide determined the three-dimensional orientation before insertion. Following surgery the patients were instructed to rinse with 0.12 per cent chlorhexidine for two weeks and then to recommence normal oral hygiene procedures. Periapical radiographs were taken before, and soon after surgery. The miniscrews were loaded 3 weeks after insertion.
RESULTS: Seventy miniscrews (92.1%) remained stable and could be used without any problem. The miniscrews lost to different causes were: a) one due to infection (1.3 per cent); b) three (3.9%) due to their proximity to adjacent roots, as diagnosed radiographically; c) one (1.3%) as a result of toothbrush trauma and d) one (1.3%) as a result of an unknown cause.

CONCLUSIONS: The failure rate was low and the most frequent reason was close proximity to the adjacent tooth. The likely failure was detected on follow-up radiographs. Trauma and infection were sporadic events.

61 EXAMINATION OF THE TEMPOROMANDIBULAR JOINT IN CHILDREN WITH JUVENILE IDIOPATHIC ARTHRITIS – A PILOT STUDY

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AIM: To test the diagnostic validity of a specialized clinical examination of the temporomandibular joint (TMJ) with reference to the 'gold standard', magnetic resonance imaging (MRI), in patients with juvenile idiopathic arthritis (JIA).
SUBJECTS AND METHOD: Between February and September 2006, 30 consecutive JIA patients (17 girls, 13 boys, median age 8.75 years, range 2-16 years) attending the clinic of paediatric rheumatology were recruited for this pilot study. Clinical diagnosis of TMJ involvement was based on clinical scores of active arthritis and condylar destruction (remodelling/structural changes). A clinical assessment score was developed based of the following criteria. Active arthritis was diagnosed when at least two of the following six criteria were fulfilled: 1) pain reported in the questionnaire, 2) maximal mouth opening less than 40 mm, 3) deviation in opening/closure of the mandible, 4) crepitation in either TMJ, 5) pain during maximal mouth opening; in a compression/distraction test or in TMJ palpation, and 6) pain on palpation of the masticatory muscles. Condylar destruction was diagnosed when at least two of the following four criteria were fulfilled: 1) abnormal mandibular asymmetry, 2) severe mandibular retrognathism, 3) palpable antegonial notching on either side, and 4) crepitation in either TMJ. Within one month, MRI was performed to examine TMJ inflammation and condylar destruction. Clinical and MRI findings were then compared.
RESULTS: In the MRI examination, 19 of the 30 subjects (63%) were diagnosed as having active arthritis and/or condylar destruction. Clinical examination resulted in a suspected diagnosis of TMJ involvement in 21 patients; however six of them had normal MRI findings (sensitivity 79%). On the other hand, clinical TMJ examination was normal in nine subjects, but four of these had pathological findings on the MRI (specificity 45%). Detailed evaluation of the clinical signs leading to the diagnosis of TMJ involvement suggests that a history of pain and the presence of antegonial notching may mislead decision making.
CONCLUSION: In this pilot study clinical examination was not sensitive and specific enough to allow for diagnosis of early TMJ involvement in children with JIA.

62 PERCEPTIONS OF ORTHODONTIC RESIDENTS IN CANADA

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AIM: To investigate the demographics, reasons for choosing orthodontics as a career, future directions and practice profiles of Canadian orthodontic residents, and an evaluation of their programme.
SUBJECTS AND METHOD: Ethical approval was obtained. Fifty-five orthodontic residents in the five Canadian orthodontic programmes were sent an email with a link to a website that contained a 42 item questionnaire and their answers were received anonymously.
RESULTS: The response rate was 60 per cent (36 out of 55 residents). Intellectual stimulation emerged as the most frequently cited factor influencing career choice (44%) and the second was a 'passion' for orthodontics (26.5%). Only 6 per cent were interested in full-time research and teaching and 36 per cent planned to include the treatment of cleft lip and palate and craniofacial anomaly patients in their practice. A total of 76 per cent planned to use self-ligating brackets and 79 per cent Invisalign™ in private practice. A total of 51 per cent indicated they were very satisfied with their orthodontic training. Interestingly, only 57 per cent said that they should complete a Master of Science degree and 85 per cent said that they would feel adequately prepared at the end of their training programme with the remainder being unsure. Forty-five per cent indicated that their programme did not contain any care for patients who were disabled or under serviced. Seventy-nine per cent felt that a 24-30 month long programme was too short and did not adequately prepare residents as future orthodontists. Seventy-nine percent felt that Canada should only license orthodontic residents from programmes that are a minimum of 35 months, since all Canadian programmes are 35-36 months, full-time.
CONCLUSIONS: The results from this survey provide a basis for further development of orthodontic services in Canada.

63 COMPARISON OF THREE-DIMENSIONAL LASER SCANNING AND DIGITAL IMAGES IN ANALYSIS OF DENTAL CASTS

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AIM: Several methods of measuring dental cast have been proposed, such as, digital imaging and laser scanning. The purpose of this study was to evaluate the validity of two computerized methods [two- (2D) and three-dimensional (3D)] of dental cast space analysis.
MATERIALS AND METHOD: Twenty upper and lower casts were set-up using artificial teeth, and various malocclusions created. The tooth sizes were calculated from the isolated artificial teeth out of their set-ups (the 'gold standard'). Impressions were obtained of each set-up using alginate and they were then duplicated using dental stone. Images were taken from the occlusal views of the casts by digital camera and they were also scanned with a 3D laser scanner. Measurements were obtained of the 3D digital layers and photographs with the AutoCAD software and compared with the gold standard. Using intraclass correlation coefficients of reliability, the accuracy of the methods were assessed and *t*-tests were used to evaluate differences between the methods.
RESULTS: All measurements had good correlations for the sum of tooth material from second premolar to second premolar: gold standard and digital photographs r = 0.9884, gold standard and 3D images r = 0.925. Statistically significant differences were observed ($P < 0.05$), but the differences were a 2.33 mm underestimation for the 2D method and 1.9 mm overestimation for the 3D measurements, which may be considered clinically acceptable.
CONCLUSIONS: 3D images are more accurate than digital photographs for study cast analysis. However, there are still problems in measuring tooth size in subjects with severe crowding.

64 ULTRASOUND ANALYSIS OF TONGUE FUNCTION IN PATIENTS WITH UNILATERAL CROSSBITE

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AIM: Several studies have shown correlations between unilateral crossbites (UXB) and incorrect tongue function and/or posture related to thumb sucking, visceral swallowing or mouth breathing. The aim of this study was to determine the prevalent type of swallowing and to analyze the function of the tongue in patients with UXB using ultrasonography.
SUBJECTS AND METHOD: Swallowing patterns of 28 patients (mean age 5.4 ± 1 years) with a UXB were recorded using B- and M-mode ultrasound techniques (Diagnostic Ultrasound System SSA-770A equipped with a 3.5 MHz convex transducer; Toshiba Medical Systems Corporation, Shimoishigami, Ottawara, Japan). Each patient's head was immobilized in a dental chair with a strap and the transducer was fixed using a holder. The patients were asked to drink 5 ml of water, wait 30 seconds and then swallow again. This procedure was repeated four times. The scan line for the M-mode was set in the middle of tongue for the first three swallowing cycles and at the tongue tip in the last swallowing cycle. The ultrasound signals were recorded directly on a hard disc and analyzed using eFilm Workstation 2.1.0 (Merge Technologies Incorporated). The type of swallowing was determined according to the action of the genioglossus muscle and then tongue movements (duration, range and speed) were compared within each subphase (I, IIa, IIb, IIIa and IIIb) and in the entire swallowing cycle between the somatic and visceral group.
RESULTS: Analysis of the action of the genioglossus muscle showed that 22 (78.6 %) patients with a UXB had a visceral type swallow. There was a significant difference ($P < 0.01$) between the visceral and somatic group in the duration of the entire swallowing cycle. There were no differences in the range of tongue movements between the two groups. The speed of tongue movement in phase IIa (early transport) was significantly lower in the visceral group ($P < 0.01$). The prolonged entire swallowing act in the visceral group could be explained by a longer path of the antero-inferiorly positioned tongue.
CONCLUSIONS: Ultrasound analysis of tongue function showed that the majority of patients with UXB had visceral type swallowing. The duration of the entire swallowing cycle was prolonged and the early transport phase was slower in the visceral group.

65 THE USE OF PANORAMIC RADIOGRAPHS TO ASSESS MESIO-DISTAL ROOT ANGULATION

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AIM: This laboratory based study assessed the accuracy of the panoramic radiograph in determining mesio-distal root angulation.
MATERIALS AND METHOD: A typodont dentition was fabricated and set-up into an ideal Class I occlusion using fixed appliance therapy. Radio-opaque wire struts were placed on the buccal surface of each tooth to represent the long axis of each root. The dentition was fixed accurately into a natural skull and a standardised panoramic radiograph was taken. The radiographic and true mesio-distal angulations of each tooth to a horizontal reference plane were measured using a co-ordinate measuring machine. The mesio-distal root positions were then altered to a more mesial and then a more distal position and the measurements repeated.

RESULTS: Using a variation range of ±2.5 degrees, only 26.7 per cent of the projected panoramic radiographic angulations were within this range of clinical acceptance. The greatest variation in the upper arch occurred in the canine-premolar area where the roots were projected as being more divergent. The greatest variation in the lower arch occurred in the lateral incisor-canine region where the roots were projected as being more convergent. The extent of radiographic distortion was statistically greater in the lower arch than in the upper arch in the ideal ($P < 0.05$) and distal ($P < 0.01$) root positions.
CONCLUSIONS: There is a clinically significant variation between the radiographic and the true root angulations recorded on a panoramic radiograph. Thus caution must be exercised when the using near-end of treatment panoramic radiographs in the assessment of mesio-distal root angulation.

66 PULPAL SURVIVAL OF AUTOTRANSPLANTED PREMOLARS TESTED BY LASER DOPPLER FLOWMETRY

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AIM: To investigate the first sign of pulpal survival of autotransplanted premolars using two techniques: electric pulp testing (EPT) detecting re-innervation, and a laser Doppler flowmeter (LDF) for detecting revascularization.
SUBJECTS AND METHOD: This prospective study investigated a group of patients with tooth aplasia or tooth loss. Eighty-six consecutive patients (9.2-14.4 years, mean 12.8), 47 boys and 39 girls, had a one rooted premolar transplanted from one jaw to the other. The contralateral premolar served as the control. The root stage was three-quarters of the expected root length, with an open apex wider than 1 mm. A Siemens electrometric pulp tester was used to detect the first sign of re-innervation and a LDF (Perimed) to determine the first sign of revascularization. Both methods were standardized. The dental probes of the LDF were localized using splints made of silicone rubber putty impression material (Olgart *et al*., 1988). Both dental probes were first tested on the control tooth for signs of reaction. One dental probe was then placed on the transplanted tooth, and the other on the contralateral tooth. Assessments were carried out at 1, 4, 8, 12 and 24 weeks and one year after transplantation.
RESULTS: Evidence of re-innervation was found from 2 to 12 months (mean 5.6 months) and evidence of revascularisation from 1 to 4 weeks (mean 0.7 months). Two teeth showed no re-innervation and two teeth no pulpal survival.
CONCLUSION: LDF (revascularisation) was an earlier and a more exact sign of pulpal survival than EPT (re-innervation).

67 SHEAR BRACKET BOND STRENGTH OF A NEW INDIRECT BONDING TECHNIQUE

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AIM: To investigate the bracket shear bond strength (SBS) of the indirect bonding technique, using two different impression materials and three transfer tray techniques. In addition, the effectiveness of three adhesive systems was evaluated.
MATERIALS AND METHOD: One hundred and eighty freshly extracted bovine primary incisors divided into 18 equal groups. The teeth were mounted in a die-stone base in order to simulate a dental arch. Maxillary central incisor edgewise metal brackets were bonded with Transbond XT to die-stone working models obtained using alginate (Orthoprint, Zhermack) or an elastomeric impression material (Impregum, 3M/Espe). Transparent indirect bonding transfer trays were fabricated using three combinations of materials [Memosil 2 (Heraus-Kulzer), Memosil/Duran (Heraus-Kulzer/Scheu-Dental) and Bioplast/Duran (Heraus-Kulzer/Scheu-Dental)]. The brackets were bonded using a light-cure (Filtek Supreme Plus Flowable, 3M Espe), a no-mix (Sondhi Rapid Set, 3M Unitek), and a chemical-cure (Concise Enamel Bond Resin, 3M Unitek) adhesive. The specimens were stored in water at 37ºC for 7 days and thermocycled before SBS testing. SBS were expressed in MPa and bond failure sites were classified using a modified Adhesive Remnant Index system. Data were analyzed by three-way ANOVA followed by Newman Keuls *post hoc* tests.
RESULTS: Significant differences were found between the impression materials ($P < 0.01$) and the adhesive systems ($P < 0.01$) used. No significant differences were found among the transfer trays ($P = 0.46$). Mean SBS were 13.1 ± 5.1 MPa for Orthoprint and 15.3 ± 5.2 MPa for Impregnum. The highest mean SBS were found with the Filtek (15.6 ± 5.4 MPa) and Sondhi (14.5 ± 4.7 MPa) adhesives. Significantly lower SBS were found with Concise (12.6 ± 5.4 MPa).
CONCLUSION: 1) Using the elastomeric impression material resulted in a significantly higher SBS; 2) Bonding with the light-cure (Filtek) and with the no-mix (Sondhi) adhesives produced the highest mean SBS; 3) No significant differences were found among the transfer tray techniques.

68 NEWLY DEFINED LANDMARKS FOR A THREE-DIMENSIONAL PHOTOGRAPHIC IMAGING SYSTEM

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AIM: A computer tomographic based reference frame to perform three-dimensional (3D) cephalometric analysis of both hard and soft tissues was developed (Swennen *et al.,* 2006). Additionally, the CT skin surface was augmented with three-dimensional (3D) photographs of the face to perform an extended cephalometric analysis. However, if only 3D photographs are available, some bone related soft tissue landmarks need to be redefined. In order for non-invasive imaging techniques to be of widespread use, a 3D photographic based reference frame, which has been validated on stereophotogrammetrical images, was developed. The purpose of this study was to determine the reliability and the reproducibility of a 3D cephalometric soft tissue analysis.
MATERIALS AND METHOD: To create a reliable and reproducible 3D cephalometric soft tissue analysis without the need for bony structures, most bone related soft tissue landmarks involved in Swennen's soft tissue analysis were redefined. For example, soft tissue nasion was originally defined as the midpoint on the soft tissue contour of the base of the nasal root at the level of the frontonasal suture. This landmark was now redefined as the most posterior point of the frontonasal soft tissue contour in the midline of the base of the nasal root. Thus, there was no need for the associated bony reference points. A maxillofacial surgeon and an orthodontist performed the redefined 3D cephalometric soft tissue analysis (53 landmarks) on 3D photographs of 15 patients. Both investigators marked each landmark twice with an intervening period of one month. The Euclidean distance between the landmark and the centre of the co-ordinate system of the 3D photograph was calculated. Pearson's correlation test was used to calculate the reliability coefficients (observer correlation) and the paired *t*-test to calculate the mean differences (observer error).
RESULTS: The mean inter-observer correlations of the 3D landmarks were extremely high [mean 0.999 (range: 0.98-0.99)]. The mean differences of both inter- and intra-observer error were very low (0.2 mm) compared with two-dimensional soft tissue analysis (1.0-1.5 mm).
CONCLUSION: It is concluded that the newly defined 3D soft tissue landmarks, are appropriate for clinical use.

Swennen G *et al.* 2006 A new method of 3-D cephalometry Part I: The anatomic cartesian 3-D reference system, Journal of Craniofacial Surgery 17: 314-325

69 APPLICATION OF AN AUGMENTED REALITY TOOL IN ORTHOGNATHIC SURGERY

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AIM: Augmented reality (AR) systems combine real images with virtual computer processed graphics. The X-Scope's®-'see-through' AR display consists of a portable LCD screen with a digital camera and is applied in combination with a navigation system and a pre-surgical computed tomograph. As a consequence, a three-dimensional virtual image of the planned operation outcome and a real time image of the operation site is displayed on the screen, enabling the surgeon to compare the actual situation to the pre-surgical planning and to perform adjustments. The aim of this pilot study was to compare the precision of AR assisted and conventional orthognathic surgery.
SUBJECTS AND METHOD: Seven female patients aged between 18 and 34 years. In all patients, X-Scope® was utilised to determine the position of the maxilla following ventral and cranial translocation after Le Fort I osteotomy. The position calculated by X-Scope® was compared with that determined by the conventional splint method. Differences between the two methods were assessed at eight measuring points on the bony surface of the maxilla by means of an electronic calliper immediately before osteosynthesis. Additional surgical time as a result of using the X-Scope®, was also recorded.
RESULTS: The technique was successfully applied in all patients. No statistically significant differences between the two methods could be found ($P = 0.994$, Wilcoxon test) and the range of the differences was between 0.2 and 1.3 mm. Additional surgical time in relation to the use of X-Scope® was approximately one hour, extending the average duration of the procedure from 2.1 to 3.1 hours.
CONCLUSION: The AR system is comparable with the conventional method for translocation of the maxilla. Additional surgical time through the use of the AR system should be, at least partly, compensated by a time reduction due to the fact that splints are superfluous.

70 GENE THERAPY TO ENHANCE CONDYLAR GROWTH

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AIM: Craniofacial anomalies resulting from impaired growth of the mandibular condyles require multidisciplinary intervention, which imposes a substantial burden on patients and their families. Correcting such deformities with alternative strategy-gene therapy is still uncharted territory. The aim of this research was to enhance mandibular condylar growth using

gene therapy specifically to establish an effective *in vivo* gene delivery system with recombinant adeno-associated virus (rAAV)-mediated vascular endothelial growth factor (VEGF).
MATERIALS AND METHOD: *In situ* hybridization, RT-PCR, immunostaining and western blot, transgene expression were used to detect the presence of VEGF in the mandibular condyles of 90 Sprague Dawely rats throughout the experimental period.
RESULTS: At defined time points specific osteogenetic markers (ALP and osteocalcin) and chongenetic markers (collagen type II and collagen type X) were assessed by means of biochemical techniques and their expression significantly changed from day 30. Proliferation index by PCNA staining also showed a significant increase in cell proliferation. Morphological measurement identified that the size of mandibular condyle significantly increased from day 30.
CONCLUSION: rAAV-VEGF is an efficient delivery system to induce mandibular condylar growth. This work provides the basis for future gene therapy to treat patients with craniofacial deformities.

71 COINCIDENT EXPRESSION PATTERNS OF RUNX2, SOX9, AND MYF5 DURING PRE-NATAL MORPHOGENESIS

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AIM: The complex morphological features that arise during pre-natal development of the mandible have been described, at least in three-dimensional (3D) reconstructions. Yet, knowledge of molecular mechanisms synchronizing tissue differentiation of bone, cartilage, muscle, nerve, and vasculature in the mandible is relatively sparse. During the past decade an increasing number of genes have been identified that are required for differentiation of various embryonic precursor populations such as osteocytes (e.g., Runx2), chondrocytes (e.g., Sox9), and myocytes (e.g., Myf5). However, what remains unclear is the extent to which spatiotemporal expression of these genes relates to the creation of mandibular form. In order to identify determinant morphogenetic factors, mandibular development was investigated using serial sections of embryonic quail (stages HH 26 to HH 38).
MATERIALS AND METHOD: Expression patterns of Runx2, Sox9, and Myf5 were assayed by means of *in situ* hybridization. Histological contours of the tissues and the domains of molecular activity were digitized using the software analysis, SIS, Münster, and 3D reconstructions were undertaken. Thus, for the first time, the degree of congruence between gene expression and tissue formation could be shown in the mandible of the quail.
RESULTS: While the expression domains of Sox9 with cartilage and Myf5 with muscles were highly correlated, expression of Runx2 was much broader than the region differentiating as bone. Thus, it could be hypothesized that there is either a temporal disconnect between Runx2 expression and bone formation, or other osteogenic markers might more closely parallel the final morphology of bone in the mandible.

72 VALIDITY AND REPRODUCIBILITY OF DIGITAL AND PLASTER MODELS

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AIM: Digital dental casts are being used increasingly for orthodontic diagnosis and treatment planning. Some information is available from the literature regarding the reliability of digital models obtained by a laser scanner. A cone beam computed tomographic (CBCT) scanner can also be used to produce a digital model. The aim of this study was to compare the reliability of digital models produced using a CBCT and a laser scanner, using the same software (Digimodel®).
MATERIALS AND METHOD: Six pre-treatment plaster models were used. From these plaster models, impressions were taken and duplicate models made. The duplicated plaster models were then scanned using a CBCT and a laser scanner. The following variables were measured on the models (plaster and digital): overjet, overbite, mesio-distal crown distances, intercanine distance, intermolar distance and available space. All measurements were performed by two observers (interobserver reliability) and each observer repeated these measurements eight times (reproducibility).
RESULTS: There were no statistically significant differences between the plaster and the digital models made with either a CBCT or a laser scanner. However, measurements made on the CBCT models were more reproducible than measurements on plaster models and laser scanned digital models.
CONCLUSIONS: Digital models are a good and reliable alternative to plaster casts. Since the reproducibility of CBCT digital models was better than laser scanned digital models, the former may be preferred.

73 REGULATORY EFFECTS OF BIOMECHANICAL STRAIN ON THE INSULIN-LIKE GROWTH SYSTEM IN HUMAN PERIODONTAL LIGAMENT CELLS

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AIM: Periodontal ligament (PDL) cells are subjected to complex biomechanical forces during orthodontic tooth movement, mastication, and occlusal trauma. Biomechanical loading can promote remodelling but also induce loss of tissue structure and function. The insulin-like growth factor (IGF) system is critical for cell proliferation as well as matrix synthesis and, therefore, of major importance for PDL remodelling. The objective of this *in vitro* study was to determine if dynamic and static biomechanical strain can regulate the gene expression of members of the IGF system in human PDL cells.
MATERIALS AND METHOD: Human PDL cells were harvested from caries-free and periodontally healthy teeth, grown in DMEM, seeded on collagen type I-coated BioFlex® plates (Flexcell® International, North Carlolina, USA), grown to 80 per cent confluence at 37ºC in 5 per cent CO_2, and subjected to dynamic and static equibiaxial tensile forces at a magnitude of 3 and 20 per cent for 4 and 24 hours. Unstretched cells served as controls. The gene expression of IGF1, IGF2, IGF1 receptor (IGF1R), and IRS1 (insulin receptor substrate 1) was determined by real-time RT-PCR at 4 and 24 hours. Data were analyzed by the comparative threshold cycle method. For statistical analysis, one-way ANOVA and the *post hoc* multiple comparison Tukey tests were applied. Differences were regarded as statistically significant at values of $P < 0.05$.
RESULTS: Unstretched PDL cells expressed IGF1, IGF2, IGF1R, and IRS1. The gene expression of these molecules was strongly affected when cells were exposed to dynamic and static biomechanical forces. Dynamic strain at a magnitude of 3 per cent induced a significant increase in IGF1 and IGF1R at 4 hours. By contrast, dynamic strain of 20 per cent inhibited the expression of the IGF system. Although the inhibitory effect of dynamic strain of 20 per cent was not significant at 4 hours, cells that were subjected to high dynamic strain for 24 hours expressed significantly less IGF1, IGF2, IGF1R, and IRS1 as compared with unstretched cells. In general, static biomechanical strain at both magnitudes downregulated the IGF system.
CONCLUSIONS: Biomechanical loading of the PDL can regulate components of the IGF system and, therefore, cell proliferation and matrix synthesis in the human PDL. The beneficial and harmful effects of dynamic mechanical loading on human PDL are magnitude-dependent. Furthermore, static strain does not seem to stimulate the IGF system.

74 FRICTION-REDUCED ORTHODONTIC WIRES COATED WITH FULLERENE-LIKE NANO-PARTICLES**

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AIM: To evaluate the efficacy of inorganic fullerene-like nano-particles coated archwires in reducing static friction at the onset of sliding mechanics. These nano-materials are known for their high lubricating properties. Tenne *et al.* (1992) first described the inorganic fullerene-like tungsten disulphide (IF-WS2) phase. The size of these nano-particles range from 20 to 200 nanometres and are constructed of multiple layers that resemble an onion or a nanotube.
MATERIALS AND METHOD: Orthodontic rectangular stainless steel wires, 0.019×0.025 inch, were coated with IF-WS2 using a composite Ni-P electrolysis coating process. To simulate sliding tooth movement, an *in vitro* model was utilised. Upper right central incisor stainless steel brackets (0.022×0.028 inch) were bonded with cyanoacrylate glue to aluminium plates by a bracket-mounting device. These plates were then connected to the base of an Instron through a device with three different notches angled at 0, 5 and 10 degrees to the long axis of the wire. Angulations represent the contact angle between the wire and bracket during tooth movement. The wires were then inserted into the slots in the brackets and ligated with an elastomeric module.
RESULTS: There was a small, but significant, reduction of 17 per cent at an angle of 0 degrees. A more substantial reduction in the frictional force (46 per cent) was recorded at the 5 degree angle and a 54 per cent reduction at the highest angle tested. At the first stage, when the angle between the slot and wire was set at 0 degrees, i.e. the bracket slot moves parallel to the wire, the IF nano-particles acted as spacers and reduced the number of asperities that come in contact thus resulting in a lower coefficient of friction. As the angle increases, the load at the edges of the slot increases, and it is probably at this point on the coated wire that the exfoliation of some of the nano-particles occurs, resulting in dry lubrication of the sliding mechanics. When nano-particles are at the interface under high loads (10º), the sliding occurred at the interface between these thin sheets of exfoliated particles, thereby substantially reducing friction.
CONCLUSIONS: Coating of the orthodontic wire with Ni-P+IF-WS2 has the potential to substantially reduce friction. Further biocompatibility investigations are needed before this coating can be utilized in orthodontic treatment.

75 CYTOKINES IN CREVICULAR FLUID AND ORTHODONTIC TOOTH MOVEMENT: A SYSTEMATIC REVIEW

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AIM: Knowledge of the relationship between cytokines and tooth movement is still limited. The aim of this systematic review was to evaluate studies on gingival crevicular fluid (GCF) cytokines for their potential role as a monitor of clinical outcome and to assess their profiles during orthodontic treatment.

MATERIALS AND METHOD: Key databases were searched using MESH terms of 'tooth movement' and 'crevicular fluid'. From each study that satisfied the inclusion criteria, the data were extracted into three categories: orthodontic mechanics, GCF sampling/handling methods, and cytokine measurements.
RESULTS: Nineteen studies were included. Various designs were used to study cytokines which limited comparison of the investigations. The common drawbacks consisted of short durations, repeated sampling, mixed age and small numbers of study subjects. Associations existed between cytokines and pain, velocity of tooth movement, treatment mechanics, and age of the subjects. Several aspects still need to be clarified, including the specificity of tension and compression, total amount or concentration in the expression of cytokine levels, proper controls, and the specificity of up-regulations in relation to biological interpretations. The most consistent result was a peak in cytokine levels at 24 hours. Interleukin-1ß (IL-1ß) and prostaglandin E_2 (PGE_2) showed different patterns of up-regulation, with IL-1ß more responsive to the intensity of mechanical stress and PGE_2 more to the synergistic regulation of IL-1ß. Moreover, data on IL-1ß collectively showed that heavy decaying force tended to significantly decrease IL-1ß levels at 168 hours, which may suggest timing reactivations to maintain sufficient IL-1ß production; on the other hand light continuous force tended to maintain relatively high IL-1ß levels for a longer period which may reduce the frequency of reactivations. These results provide evidence at the cellular level for the use of light continuous force in daily practice.
CONCLUSIONS: Most GCF cytokines showed peak levels at 24 hours. Associations between cytokines and several aspects of tooth movement are indicated. IL-1ß and PGE_2 showed different patterns of up-regulation. Evidence was provided at the cellular level for the use of light continuous forces in daily practice. Future studies should focus on refinement of laboratory and clinical protocols.

76 EFFECTIVENESS OF BONDED LOWER LINGUAL RETAINERS**

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AIM: To study the effectiveness of two types of bonded lingual retainers in controlling lower anterior relapse.
MATERIALS AND METHOD: Dental casts of 370 consecutive patients. Group I (n = 235) received a 3–3 lower lingual stainless steel retainer bonded only on the canines, and group II (n = 135) a flexible spiral retainer bonded on all six lower anterior teeth. The dental casts were studied before (T0), immediately after (T1) and two (T2) and 5 (T5) years post-treatment. The Irregularity Index according to Little (1975) was used to describe the contact point displacement of the lower anterior teeth.
RESULTS: In group I, the mean Irregularity Index was reduced from 7.2 mm (SD = 4.0) at T0 to 0.4 mm (SD = 0.6) at T1 and increased during the post-treatment period to 0.7 mm (SD = 0.8) at T2 and 0.9 mm (SD = 0.9) at T5. In group II, the mean Irregularity Index was reduced from 7.4 mm (SD = 4.1) at T0 to 0.1 mm (SD = 0.3) at T1, remained stable from T1 to T2 and increased during the period T2-T5 to 0.2 mm (SD = 0.3). Twenty per cent of the patients in group I had loose retainers in the period T1-T5, whilst this figure was 40 per cent for group II.
CONCLUSIONS: The post-treatment increase in irregularity of the lower anterior teeth was small in both groups. The flexible spiral lower lingual retainer bonded on all six anterior teeth was found to be more effective in comparison with the stainless steel retainer bonded only on the lower canines. However, the flexible spiral retainers debonded more often than the stainless steel retainers.

77 COMPARISON OF CEPHALOGRAMS GAINED FROM CONE-BEAM IMAGES TO LATERAL CEPHALOGRAMS

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AIM: Three-dimensional (3D) cone-beam imaging is increasingly used for diagnosis and treatment planning in orthodontics. As methods for 3D measurements are being developed, two-dimensional (2D) lateral cephalograms may be generated from 3D datasets. This study presents a comparative analysis of landmark identification on 2D cephalograms generated from 3D cone-beam datasets and those identified on conventional lateral cephalograms.
MATERIALS AND METHOD: Conventional lateral cephalograms and cone-beam images of 12 patients taken within six months were selected. The conventional cephalograms were generated with the Orthophos unit and the cone-beam images with the Galileos device, both Sirona Dental Systems, Germany. The 3D images were acquired in one single rotation scan and the primary and secondary reconstruction was achieved using its software (Galaxis). The 2D cephalograms from the 3D datasets (thickness of 150 mm) were generated through an X-ray sum image aligned to sagittal, coronal and axial reference planes. The generated cephalograms (resolution 96 dpi) and the scanned conventional cephalograms were imported into

the program, Winceph®. Ten observers identified 26 skeletal, dental and soft tissue landmarks and described the quality of locating the landmarks. Scatter plots were produced for each landmark. In addition, a correlation coefficient described the relationship between the size of the scatter plots and the quality of locating the landmarks.
RESULTS: The images generated from cone-beam datasets created acceptable 2D cephalograms that can be imported into any third-party cephalometric analysis software. There was no significant difference in locating skeletal and dental landmarks between the conventional and generated cephalograms and the scatter plots were more widely spread for radiological or constructed landmarks in both conventional and generated cephalograms. However, the scatter plots of the soft tissue landmarks showed significant deviations in the generated cephalograms.
CONCLUSIONS: With the assistance of its proprietary software, 2D cephalograms can be created from 3D datasets acquired with the Galileos device. The generated images allow accurate and efficient location of skeletal and dental landmarks comparable with that of conventional cephalograms and therefore question the need for these.

78 RELAPSE AND STABILITY FOLLOWING A HIGH SAGITTAL SUPRAFORAMINAL OSTEOTOMY OF THE MANDIBLE

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AIM: To investigate the stability of mandibular advancement and set back procedures using the high sagittal supraforaminal osteotomy (HSSO) of the mandibular ramus, according to Hoeltje and Scheuer (1992). In this type of osteotomy the bone cut leaves the buccal cortical surface at the anti-lingula prominence in order to preserve nerve function.
MATERIALS AND METHOD: Computerized cephalometric radiographs of 102 patients, taken at four different times during treatment. Statistical evaluations were carried out using the SPSS statistical program. Intra-individual differences, correlations and regression analyses were established to find predictors for future stability within the pre-operative dataset.
RESULTS: The mean post-surgical relapse was 20 per cent. The post-surgical relapse depended on the amount of surgical correction (correlation coefficient: –0.68). Mandibular set backs were more stable than mandibular advancements. Excessive mandibular advancement was shown to be less stable than a moderate amount of advancement. Posterior rotation of the mandible increased the stability of mandibular advancement. The type of osteosynthesis (positional screw combined with miniplate osteosynthesis or intermaxillary fixation) did not appear to influence stability. Mandibular osteotomies were more stable than bimaxillary procedures ($P < 0.001$). In the groups 'retrognathia without vertical problems' or 'skeletal deep bite', cephalometric parameters (ANB, SNB) showed no relapse, with a slight change at SNPg of 0.5 per cent. The relapse was 32.5 per cent in patients with retrognathia and an open bite (SNB). Patients with mandibular prognathism showed a relapse of 15.6 per cent (SNB).
CONCLUSION: Dividing patients into cephalometrically defined diagnostic groups, depending on their facial form, may provide some information regarding potential relapse when planning combined orthodontic-surgical treatment. These findings are relevant for pre-surgical orthodontic treatment and surgical planning.

79 COMPARISON OF FOUR DIFFERENT MAXILLARY EXPANDERS: EARLY DENTAL RESULTS**

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AIM: To evaluate the modifications in transverse dimensions and palatal shape.
SUBJECTS AND METHOD: Seventy patients (38 females, 32 males), in the early mixed dentition requiring maxillary expansion. The patients were randomly allocated to treatment with an expander appliance as follows: 18 patients (9 females, 9 males) with a Hyrax bonded on the primary second molars; 16 patients (10 females, 6 males) with a Haas bonded on the primary second molars; 18 patients (9 females, 9 males) with a Hyrax bonded on the first permanent molar; 18 patients (10 females, 8 males) with a Haas bonded on the first permanent molar. All expanders were activated daily for 4 weeks and for a total of 7-9 mm. Impressions of the upper arch were taken in alginate, at the beginning of treatment and at the end of expansion. The models were duplicated and then sectioned at the level of a line passing through the lingual sulcus of the upper first molars and at the level of a line passing mesially to the primary first molars or first premolars. The following measurements were taken posteriorly: intermolar diameter at the sulcus level; intermolar diameter at gingival sulcus level; palatal width at its deepest point; palatal width half way between the deepest point and the gingival sulcus, and anteriorly: intercanine diameter at the canine level; intercanine diameter at the gingival sulcus level; palatal width at its deepest point, and palatal width half way between the deepest point and the gingival sulcus.
RESULTS: The acrylic expander placed on the primary second molar produced marked expansion of the premolars and increased the intercanine width; the non-acrylic expander on the first permanent molar produced only minor expansion of the premolars and also created some increase in intercanine width.

CONCLUSIONS: It can be assumed, that to achieve maximum anterior expansion, an acrylic expander should be used on the primary second molar.

80 EXPRESSION OF ETA AND ETB RECEPTOR SUB-TYPES DURING TOOTH MOVEMENT IN RATS

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AIM: Endothelin-1 (ET-1) is the predominant and most important isoform of endothelin in humans. It is released due to intravascular shear stress, hypoxia and ischaemia, which are also present after orthodontic force application. ET-1 is probably released in the periodontal ligament (PDL) and alveolar bone during tooth movement. It has been already established that tezosentan, an endothelin dual antagonist, enhanced tooth movements in rats. ET-1 activates two receptor sub-types, endothelin A and B receptors (ETA and ETB). The aim of this study was to determine the expression rate of ETA and ETB on mRNA level during orthodontic tooth movement in rats.
MATERIALS AND METHOD: Twenty-eight male Wistar rats divided into four equal groups. In all animals, a closed coil spring was placed between the upper left first molar and upper left incisor. Animals in group I (control group) were sacrificed on day 0, group II on day 14, group III on day 28 and group IV on day 42. Tissue samples of the alveolar bone, with all three molars and their PDL were taken. Total RNA was isolated from these tissue samples using TRIzol reagent. The ETA and ETB expression levels were assessed by means of relative RT-PCR using subtype-specific primers. Relative expression levels of the ETA and ETB mRNA were normalized against the GAPDH mRNA as a control. Microsoft Office Excel 2003 and a Student's *t*-test were used for statistical analysis.
RESULTS: During the experiment, the expression level of ETB was 1.5 to 1.8 times higher than ETA expression level ($P < 0.05$). The expression of ETA was not different during the first 28 days compared with day 0. However, there was approximately a two-fold induction in ETA mRNA level between days 0 and 42 of the experiment ($P < 0.05$). In contrast, the expression of ETB was significantly different during the whole experiment. At 14 and 28 days, there was a 2.5-fold and a 1.7-fold induction, respectively, when compared with day 0 ($P < 0.05$). The expression of ETB was further induced (up to 3.3-fold) after 42 days, when compared with day 0 ($P < 0.001$). The results show a significantly higher expression of ETA in the last phase of tooth movement, while the expression of ETB was significantly higher throughout all phases of tooth movement.
CONCLUSION: The findings demonstrate the differential expression of the genes coding for ETA and ETB receptor sub-types during several phases of tooth movement in rats.

81 HOW TO AUGMENT THE THREE-DIMENSIONAL VIRTUAL SKULL MODEL WITH A DETAILED DENTAL SURFACE

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AIM: To evaluate the use of a double computed tomographic (CT) scan procedure to augment the three-dimensional (3D) virtual skull model with a detailed dental surface using both multi-slice CT (MSCT) and cone-beam CT (CBCT) techniques.
MATERIALS AND METHOD: Firstly, the combination of a 3D acrylic wafer in combination with a double MSCT scan procedure was evaluated on 10 dry adult human cadaver skulls. Both the cadaver skulls and the plaster dental casts were scanned with the 3D acrylic wafer in place. An automatic point-based rigid registration method was used for fusion of both CT datasets. Modifications were necessary to use the technique in a clinical setting. Instead of the 3D acrylic wafer, the use of a modified wax bite wafer was assessed in a clinical pilot study on a total of 10 patients. Instead of scanning the plaster dental casts, the impressions of the upper and lower arches and a modified wax bite wafer were scanned. Fitting of the virtual impressions on the wax bite wafer was undertaken by surface matching using iterative closest points (ICP). Consecutively, automatic rigid point-based registration on the wax bite wafer on the patient scan was performed. Finally, CBCT scanning of the patient, impressions of the dental arches and the wax bite were performed in a second clinical pilot study.
RESULTS: Analysis of the accuracy of the automatic point-based rigid registration method for fusion of both MSCT datasets in the cadaver study showed that the registration error ranged from 0.04 to 0.35 mm. The error distribution histograms of the MSCT clinical pilot study showed errors of 0.16 (25th percentile), 0.31 (50th percentile) and 0.92 mm (90th percentile) for ICP surface matching. The mean registration error for automatic point-based registration was ±0.07 mm (range: 0.12-0.22 mm). The error distribution histograms of the CBCT clinical pilot study showed errors of 0.22 (25th percentile), 0.44 (50th

percentile) and 1.09 mm (90th percentile) for ICP surface matching. The mean registration error for automatic point-based rigid registration was 0.18 ± 0.10 mm (range: 0.13-0.26 mm).
CONCLUSION: The results of this study show the potential use of a double CBCT scan procedure with a modified wax bite wafer to set-up a 3D virtual augmented model of the skull with a detailed dental surface and reduced radiation exposure.

82 A COMPARATIVE STUDY OF THE EFFECTS OF BISPHOSPHONATE (CHLODRONATE) AND BIOGLASS
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AIM: To compare the effect of bisphosphonate (chlodronate) and a new bioglass synthetic hydroxyappatite material on the amount of orthodontic tooth movement in male dogs.
MATERIALS AND METHOD: Twenty male strain dogs divided into two equal groups. Each group received local administration of each material on one side while the contralateral side served as the control for both groups. Banding of the second premolar and canine was performed on both sides followed by surgical extraction of the first premolar. A uniform standardized 0.012 inch nickel titanium closed coil spring was set in the mouth of each animal between the upper second premolars and canines on both sides and ligated. The spring was stretched and initially generated a force of 100 g on each side. Each dog received 50 uL of chlodronate solution (0.9% NaCl, pH 7.4) at a concentration of 250 umol/L which was injected into the sub-periosteum area adjacent to the upper left second premolar every week during the one month period of the experiment. In the second group, bioglass material was locally injected at the second premolar area in the same way as for the first group. For both groups, the right side served as control with an injection of 50 uL of 0.9 per cent sodium chloride once per week for one month into the corresponding area.
RESULTS: A significant retardation of second premolar movement in the bisphosphonate group was found where the percentage of inhibition of tooth movement was approximately 30 per cent in the bioglass group and 80 per cent of the control side. Histologic examination revealed that in the experimental animals a greater number of osteoblasts appeared on the alveolar bone surface at a highly significant level when compared with the control sides, and inhibition of tooth movement was observed.

83 CHANGES OVER 8 YEARS OF THE GINGIVAL CONTOUR OF UPPER CENTRAL INCISORS
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AIM: Smile aesthetics are a decisive factor in orthodontics when considering the correct vertical position of the upper incisors. Many authors have advocated the ideal exposure of gingiva but there is little information regarding the long-term changes of the gingival margin level. The aim of this study was to monitor changes in gingival contour, in adolescents and adults, over an 8 year period.
SUBJECTS AND METHOD: Ten adolescents (3 males, 7 females, mean age 14.8 years), and 10 young adults (3 males, 7 females, mean age 27.7 years). Photographic records were obtained 2 and 10 years after orthodontic treatment, with all photographs taken parallel to the occlusal plane. All patients were out of retention when the first records were taken. The contour of teeth 11 and 21, the midline passing through the contact point of the teeth, and the height of the papilla were traced using drawing software. Each pair of drawings was superimposed according to a standardised method, taking into account possible attrition. The dental casts were used to calibrate the magnification error of the drawings. Seven lines parallel to the midline divided each upper central incisor into eight equal parts. Gingival recession was measured on each of these seven lines and the level of the papilla was also calculated. The error of the method was tested on two photographs of the 10 subjects taken on the same day on two different occasions. Each measurement showed high repeatability (error range 0.03-0.06 mm for gingival measurements and 0.12 mm for the level of the papilla).
RESULTS: Over an 8 year period, adolescents showed a mean apical displacement of the gingival margin of 0.60 mm (S.D. 0.28 mm, range 0.21 to 1.17 mm). The gingival margin of the young adults showed less apical displacement (mean: 0.04 mm, S.D. 0.13 mm) ($P < 0.01$). The mean apical displacement of the papilla was 0.52 mm (S.D. 0.47 mm) for the adolescents, whilst a small coronal displacement (mean: 0.15 mm, S.D. 0.62 mm) was measured for the adults ($P = 0.013$).
CONCLUSIONS: Apical displacement of the gingival margin of the upper central incisors takes place during adolescence. At the end of the orthodontic treatment, it should be borne in mind that the level of the gingiva may change. Thus, eventual gingival surgery for aesthetic reasons should be postponed and re-evaluated in early adulthood.

84 AUTOMATED DETERMINATION OF SKELETAL MATURITY**
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AIM: An entirely new method (BoneXpert) for automated determination of skeletal maturity from a hand wrist radiograph is presented and validated against the Greulich Pyle (GP) atlas.
MATERIALS AND METHOD: BoneXpert reconstructs the borders of the radius, ulna and 13 short bones in the hand automatically by matching each bone to a deformable template model, which is also able to validate that the bone has been reliably reconstructed. Features describing the shape, density distribution and textural properties of the bone are extracted and used to predict bone age. The set of 15 bone age values were validated against each other for consistency before computing the average, denoted BoneXpert's intrinsic bone age. The system was developed based on a large cross-sectional study of 951 normal school children from Denmark (7-17 years) conducted by Helm (1966). The data was supplemented by 186 images of 2-7 year old children from several hospital clinics, primarily Rigshospitalet, Copenhagen.
RESULTS: The intrinsic bone age agreed, on average, with the chronological age of the population used for development. Using a 7-parameter polynomial, the intrinsic bone age was transformed to agree with the nominal bone age of 37 plates scanned from the GP atlas. The standard deviation between the nominal and predicted GP bone ages, evaluated using leave-one-out cross validation, was found to be 0.34 years [95% CI 0.27; 0.43].
CONCLUSION: Since BoneXpert can analyse all normal hand wrist radiographs automatically, objectively and in excellent agreement with the 'gold standard', it may be a valuable tool in clinical orthodontics. The method can be integrated into modern IT systems for digital radiography and electronic patient records leading to an efficient and safe workflow.

85 A NEW METHOD FOR THREE-DIMENSIONAL TOOTH MOVEMENT ANALYSIS

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AIM: Recent developments in computer imaging have made it possible to analyze tooth movements in three-dimensions (3D). The aim of this study was to evaluate a new method for tooth movement analysis in 3D, based on digital study casts using the Tooth Measure software (version 1.1, Align Technology©, Santa Clara, California, USA).
MATERIALS AND METHOD: Initial and final plaster casts of 50 adult patients treated for a deep bite were digitized with an industrial computer tomographic scanner (Align Technology©). The digital models were segmented into teeth and gingivae and body co-ordinate systems were assigned to each tooth in the initial cast and transferred to the corresponding tooth in the final cast by tooth-to-tooth geometric matching. A common reference frame for measurements was established by superimposing initial and final casts on stable rugae points. The movement of the body co-ordinate system was used to calculate the 3D movements for each individual tooth. The movement of each tooth was described by translation along three axes (*X, Y, Z*) and rotations around three axes (Rx, Ry, Rz) of two independent co-ordinate systems: a global and a tooth-based. In addition the change in inclination and the vertical movement of the incisal edge of the upper incisors were recorded.
RESULTS: The error of the method was calculated to be 0.15 mm for translations and 1 degree for rotations. The deep bite was, in all cases, corrected but the tooth movements performed to obtain the correction varied so much that the data could not be pooled. Important information could be gained by 3D analysis of individual cases.
CONCLUSION: A valid method for the evaluation of tooth movement in space was developed. 3D analysis demonstrated that the variation in individual tooth movement, even in patients with similar malocclusions, makes the analysis of pooled data meaningless. The possibility of analyzing tooth displacement in this way provides an important tool for improved understanding of biomechanics and tooth movement. The tooth movement analysis with respect to stable structures simulated a conventional analysis on superimposed lateral cephalograms and allowed analysis of each tooth separately.

86 QUALITY EVALUATION OF ORTHODONTIC INFORMATION ON THE 'WORLD WIDE WEB'

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AIM: The Web stores an enormous amount of health care information and provides unlimited opportunities to access information. However, there is no central control or regulatory policy regarding publication on the Web. The purpose of this study was to develop standards and to perform a quality evaluation of orthodontic Web sites.
MATERIAL AND METHODS: Google, Yahoo and Microsoft Network (MSN) search engines were used to search the keyword 'orthodontics'. The engines provided approximately 225,000 to 921,000 results. The first 50 hits from each search engine were visited. Only the pages that provided orthodontic information either for professionals or the public were evaluated. The quality assessment criteria included: type of target audience, availability of authorship and last update, and attributions and quality of the information provided.
RESULTS AND DISCUSSION: Following exclusion of irrelevant hits, MSN had 30, Yahoo 28, and Google 25 websites. Of these pages, 36.4 per cent were provided by doctors' practices, 18.8 per cent by vendors, 18.8 per cent by non-commercial

web site owners, 11.4 per cent by orthodontic organizations, 10.8 per cent by schools and 4 per cent by journals. The percentage of pages for the public was 64.3. Authorship was not revealed in 64.2 per cent, attributions were not listed in 67.2 per cent, the last update was not given in 71.6 per cent and the information provided was considered correct in 97 per cent of the pages visited.
CONCLUSIONS: The results indicate a variance in orthodontic information. It is not easy to define and classify the sources of information. It also seems to be a great challenge to judge whether the information presented is applicable and credible. In general the more professionally orientated information met more definitive standard criteria and, in contrast, the information designed for the general public met fewer standards.

87 CAN WE PREDICT REMAINING CRANIOFACIAL GROWTH WITH HAND-WRIST RADIOGRAPHS?
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AIM: Knowledge of craniofacial growth is essential for successful orthodontic treatment. Hand-wrist radiographs have traditionally been used to evaluate skeletal maturation and estimate the remaining growth in young patients. However, it remains controversial as to how reliably craniofacial growth can be predicted using this method. It was the aim of this study to investigate the validity of the hand-wrist radiograph method in estimating the amount of remaining craniofacial growth.
SUBJECTS AND METHOD: From a sample of 485 well documented cases treated at the Clinic for Orthodontics and Pediatric Dentistry, University of Zurich, 49 patients (22 males, 27 females) with a Class I malocclusion were selected. At the beginning of treatment, the mean age of the females was 11.10 years and of the males 12.6 years. At the end of treatment, it was 14.7 years in females and 15.3 years in males. Statural height was measured and a lateral cephalogram was obtained for every patient at the beginning and end of treatment. A hand-wrist radiograph was taken before treatment. Cephalograms were scanned and computer analysed (Winceph). Changes in statural height during treatment were calculated, as well as changes in the lengths of the cranial base (N-S), maxilla (Ptm-A) and mandible (Go-Gn). Changes were analysed statistically and compared with the growth prediction assessed using the hand-wrist radiograph method according to Greulich and Pyle.
RESULTS: A high correlation (males: $r = 0.7$ females: $r = 0.65$) was found between statural growth increases and growth prediction as assessed from the hand-wrist radiographs. Growth increases in the mandible showed the highest correlation with statural growth (females: $r = 0.39$; males: $r = 0.51$). However, this association would not allow for reliable growth prediction. Only weak correlations existed between the different craniofacial structures. There was no significant correlation between growth increases in the cranial base, the maxilla and the mandible and the growth prediction assessed with the hand-wrist radiograph. Therefore, growth prediction determined by the Greulich and Pyle method cannot be considered as clinically reliable when estimating remaining craniofacial growth.
CONCLUSIONS: The validity of the hand-wrist radiograph method in predicting remaining craniofacial growth must be questioned.

88 ORTHODONTIC LOAD TO SHORT MAXILLARY IMPLANTS WITH REDUCED INSERTION DEPTH
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AIM: To evaluate positional stability and peri-implant tissue findings of orthodontically loaded short osseointegrated implants with a reduced insertion depth.
MATERIALS AND METHOD: Four maxillary premolars extracted from each of four adult foxhounds (3 years). After a 10-week alveolar healing period, four Orthosystem implants (Institute Straumann, Waldenburg, Switzerland) were inserted into the edentulous alveolar bone and one in the palate. All implants were 4 mm in length. The endosseous part of the implants was intentionally partially submerged in order to reduce the insertion depth (<4 mm). After a 10-week implant healing period the test implants were loaded for 24 weeks with a continuous force of 2 N. Clinical criteria for analysis were: implant loss during the implant healing and loading period, percussion sound and positional stability (metric measurement). Histological evaluation criteria included insertion depth and percentage of direct bone contact at the implant surface.
RESULTS: One palatal implant was lost during the implant healing period. In this dog coil springs were applied between the two alveolar bone implants on each side. In the remaining three dogs transpalatal arches (TPAs) were inserted between the two distal alveolar bone implants and coil springs between the TPAs and the palatal implants. Thus, 13 loaded test implants (alveolar = 10, palatal = 3) and six unloaded controls (alveolar) could be evaluated. The test implants and control implants remained positionally stable and revealed a clear sound upon percussion during the experimental period. Submersion depth of some implants was less than two-thirds of their endosseous implant length, corresponding to less than 3 mm of insertion depth. Mean bone contact for the test implants was 80.28 per cent and 70.56 per cent for the controls.

CONCLUSION: Osseointegrated titanium screws with an insertion depth of less than 3 mm are suitable for long-term orthodontic anchorage.

89 LOWER FIRST VERSUS SECOND PREMOLAR EXTRACTION THERAPY

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AIM: To retrospectively study the possible effects of lower first versus lower second premolar extractions and orthodontic space closure within the mandibular dentition.
SUBJECTS AND METHOD: Twenty-two patients (mean age 11.1 years, SD 1.5 years) with lower first premolar extractions (1EX group) and 24 patients (mean age 11.9 years, SD 1.5 years) with lower second premolar extraction (2EX group). All patients were treated using the same standard edgewise technique with no difference in initial crowding or treatment duration between the groups. On the lateral cephalograms obtained before and after space closure, skeletal and dental landmarks were digitized and superimposed using a co-ordinate system. The menton-gonion line served as the *x*-axis and a perpendicular line through pogonion as the *y*-axis. Changes in the position of the lower dentition were studied in the sagittal and vertical directions.
RESULTS: During treatment the incisors in the 2EX group were distalized more than those in the 1EX group (mean 2.1 and 1.4 mm, respectively). Highly significant annualised differences in incisor position occurred vertically: 0.6 mm mean annual elongation in the 2EX group versus 0.2 mm in the 1EX group. No difference was noted in the lower first molar position between the groups. The lower occlusal plane displayed 3.4 degrees posterior rotation in the 1EX group and 1.7 degrees anterior rotation in the 2EX group.
CONCLUSION: The findings have clinical implications with regard to overbite: extraction of lower second premolars tends to close the bite compared with extraction of lower first premolars.

90 ORTHODONTICS: EFFECTS ON ORAL HEALTH-RELATED QUALITY OF LIFE

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AIM: The Child Perceptions Questionnaire for 11 to 14-year-old children (CPQ11-14) has been shown to be a valid and reliable measure of oral health-related quality of life (OHRQoL) in a sample of Canadian children (Jokovic *et al*., 2002). The aims of this study were: 1) to assess the validity and reliability of the CPQ11-14 in a sample of American children and 2) to evaluate the effect of comprehensive orthodontic treatment on OHRQoL.
SUBJECTS AND METHOD: A convenience sample of 11 to 14-year-old children was recruited: paediatric dental treatment group (n = 64); orthodontic treatment group (n = 68); and craniofacial anomaly group [n = 64; subdivided into unilateral (n = 30) and bilateral (n = 18) cleft groups]. The children completed the CPQ11-14 and a second, identical questionnaire two weeks later. Validity was assessed indirectly by comparing the total CPQ11-14, to determine if the initial scores increased in accordance with the presumed severity of the oral condition (paediatric presumed least severe and bilateral cleft the most severe). Subjects who reported no changes in either oral health or related overall well-being were included in the reliability part of the study. The paediatric and craniofacial groups also completed the CPQ11-14 at 24 months, whilst the orthodontic group completed the CPQ11-14 at 6 months post-orthodontic treatment.
RESULTS: The CPQ11-14 appeared to be reliable, the intraclass correlation coefficient and associated 95 per cent confidence intervals for the overall CPQ11-14 was 0.79 (0.71 to 0.86), and was similar to those from the Canadian children. The CPQ11-14 was also valid: baseline scores for the groups were in the presumed order of severity: paediatric (23.08) < orthodontic (23.29) < unilateral cleft (33.97) < bilateral cleft (41.89). Final CPQ11-14 scores were: orthodontic (15.14) < paediatric (19.54) < unilateral and bilateral cleft (32.76). Over time, both group type and time had significant effects on the total CPQ11-14 scores ($P < 0.05$, factorial ANOVA). The CPQ11-14 improved for all groups ($P<0.05$). There were significant differences between the final CPQ11-14 scores for the orthodontic group and the bilateral cleft group and between the bilateral group and the paediatric group ($P < 0.05$).
CONCLUSIONS: The CPQ11-14 is a reliable, valid measure of OHRQoL. OHRQoL improved with time but comprehensive orthodontic treatment did not significantly improve OHRQoL compared with the untreated control group.

Supported in part by the Delta Dental Fund.

91 OSTEOCLAST DIFFERENTIATION IN THE EARLY STAGES OF EXPERIMENTAL TOOTH MOVEMENT

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AIM: MMP-9 is essential for macrophage and osteoclast migration, while it is not expressed in resident macrophages. ED1 has been used as a common macrophage lineage marker and MMP-9 as a migration marker. It was hypothesized that in the normal periodontium, macrophage lineage cells will appear as ED1+/MMP9- mononuclear cells and, after force application, some of these cells would express MMP9 and further differentiate into osteoclasts.
MATERIAL AND METHODS: Forty rats divided into eight groups. The upper three molars on one side were moved mesially using NiTi coil springs, with the contralateral side as the control. After 6, 12, 24, 36, 48, 72, 96, and 120 hours, the animals were processed for immunohistochemistry, in order to study the spatial and sequential expression of ED1 and MMP9.
RESULTS: In the normal rat periodontium, ED1+ mononuclear cells outnumbered MMP-9+ mononuclear cells. ED1+ and MMP9+ multinuclear cells were equal in number. After force application, ED1+/MMP-9+ multinuclear cells first increased in the adjacent bone marrow. There was an initial decrease in the number of ED1+ mononuclear cells in the compressed PDL, followed by increase of ED1+/MMP+ mono and multinuclear cells. In the meantime, ED1+/MMP-9+ multinuclear cells decreased at tension areas.
CONCLUSIONS: Force application induces an initial decrease in the number of macrophages at the compression areas. Undermining bone resorption by osteoclasts starts earlier than recruitment of new macrophages and osteoclasts to the periodontium and the onset of frontal bone resorption. At the tension areas, the number of macrophages remains stable, but the number of pre-existing osteoclasts diminishes soon after force application.

92 EFFECTS OF MECHANICAL STRAIN ON THE EXPRESSION OF BONE SIALOPROTEIN IN CEMENTOBLASTS *IN VITRO*

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AIM: Studies have shown evidence of different phenotype and functional regulation of cementoblasts and osteoblasts. Whilst the response of osteoblasts to mechanical strain has been extensively researched, that of cementoblasts to mechanical stimuli has not been investigated. The aim of this study was to determine the effects of high and low mechanical tensile strain on the expression of bone sialoprotein (BSP) mRNA in cementoblasts *in vitro*.
MATERIALS AND METHOD: Cementoblasts were collected from the roots of newborn bovine teeth and identified with cementum-derived attachment protein (CAP) 3G9, which is a unique marker for cementoblasts. Mechanical tensile strain was applied to the cementoblasts by uniaxial four-point bending with either 2000 or 4000 μstrain at a frequency of 0.5 Hz for 3, 6, 12, 24 and 36 hours *in vitro*. BSP mRNA level was quantified by RT-PCR.
RESULTS: A large number of cementoblasts expressing CAP were identified in the culture. With 2000 μstrain, the BSP mRNA level showed a four-fold increase at 12 hours and dropped towards the baseline level at 36 hours. With 4000 μstrains, however, the response was slower and less intensive. The BSP mRNA level increased slowly, reached a peak at 24 hours, which was 2.5 times higher than baseline and decreased to the baseline level at 36 hours. The results showed that mechanical tensile strain up-regulated the expression of BSP, which is a major non-collagen protein contributing to the formation of cementum by cementoblast. These results were different from previous studies on the reaction of osteoblast to mechanical stimuli. Osteoblasts typically showed higher up-regulations of BSP mRNA, reached a peak at 24 hours and stayed at a high level thereafter. These results indicate that the BSP mRNA level may provide additional evidence of the different phenotype and functional regulation of cementoblasts and osteoblasts.
CONCLUSION: Both high and low mechanical tensile strain results in significant up-regulation of BSP mRNA in cementoblasts. Low mechanical tensile loading induces earlier and more intensive up-regulation of BSP mRNA, and may be the optimal strain to stimulate the activity of a cementoblast. The clinical relevance might be that low mechanical strain is advantageous to promote the formation of cementum to repair root resorption resulting from orthodontic tooth movement. Heavy forces, however, not only tend to induce more root resorption, but also inhibit cementum formation.

Posters

93 RELATIONSHIP BETWEEN MASSETER MUSCLE SIZE AND ORIENTATION, AND FACIAL MORPHOLOGY

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AIM: To analyse the relationship between size and orientation of the masseter muscle and facial morphology.

SUBJECTS AND METHOD: Thirty healthy, adult, Japanese female volunteers (mean age: 19.7 ± 1.8 years), with complete dentitions and normal occlusion; without clinical signs of jaw dysfunction. All subjects were examined both by helical-type computed tomography (CT) and a super conductive-type magnetic resonance image (MRI) scanner (GE, Milwaukee, Wisconsin, USA). Scanning planes were parallel to the Frankfort horizontal (FH). MRI: Sixty-four slices with a slice thickness of 2.5 mm without a slice gap. CT imaging: The slice thickness was 2.5 mm, with a slice gap of 0.5 mm. All data were reconstructed in three-dimensions using the software package, Analyze™. Volume and cross-sectional area (CSA) of the masseter muscle were determined from both data. The orientation of the muscle was measured as the angle between the tangent to the anterior border of the muscle and the FH (MsA). Facial morphology was analyzed by placing 21 skeletal landmarks on the CT-model. Based on these landmarks, 17 variables were calculated. A correlation analysis was carried out using Pearson correlation coefficients.
RESULTS: Mean values and standard deviations for both muscle volume and CSA were nearly identical for the CT and the MRI analysis (volume: 20.3 cm^3 ± 5.1 (CT) and 20.7 cm^3 ± 5.4 (MRI); area: 4.3 cm^2 ± 1.0 (CT) and 4.4 cm^2 ± 1.0 (MRI). Highly significant positive correlations were found between muscle volume and area (R = 0.93 (CT) and R = 0.92 (MRI) and negative correlations between the size of the masseter muscle and the gonial angle (R = 0.73), the inclination of the mandible in relation to FH (R = 0.60) and the vertical jaw relationship (R = 0.66). A significant, positive correlation was observed between the size of the masseter muscle and mandibular prognathism (R = 0.44). MsA showed a significant positive correlation with mandibular prognathism, i.e. the more vertical the masseter, the more prognathic the mandible and significant negative correlations with sagittal jaw relationship, mandibular inclination and face height.
CONCLUSION: Measurements of masseter muscle volume and CSA were nearly identical when data from CT and MRI scans were compared. Both the size and the orientation of the masseter muscle showed significant correlations with facial morphology, especially in terms of shape, inclination and mandibular prognathism.

94 EFFECTS OF PRE-SURGICAL ORTHOPAEDICS ON ARCHFORM IN UNILATERAL CLEFT LIP AND PALATE SUBJECTS

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AIM: To identify significant differences in archform dimension in unilateral cleft lip and palate (UCLP) infants treated with pre-surgical orthopaedics (PSO) compared with untreated PSO controls, up to 6 months.
MATERIALS AND METHOD: Seventy-five sets of study model of complete UCLP patients (PSO = 14, non-PSO = 61), treated by the same plastic surgeon and orthodontist in one cleft centre. Each set comprised study models taken close to birth, before lip repair/vomer flap (3 months) and palate repair (6 months). The groups were comparable at birth for all archform variables, as assessed by independent sample *t*-tests at a significance level of 1 per cent. Suction-retained active acrylic PSO plates were used. Thirteen maxillary archform landmarks were measured in three-dimensions and in a single-blinded manner using the Reflex microscope and COMP3D software. Sixteen linear and angular variables were computed to describe the archform in the transverse, anteroposterior, and vertical dimensions, and arch circumference. The palatal height of UCLP infants was described for the first time, adapted from a previous description of the palatal height of dentate UCLP subjects. Intraoperator repeatability tests were performed on duplicate measurements of 17 per cent of the sample to indicate the precision of measurements and to identify systematic differences. Data were analysed using the repeated measures hierarchical ANOVA to a significance level of 1 per cent, incorporating Bonferroni's post *hoc* tests to reduce the risk of spurious results.
RESULTS: Repeatability tests showed good measurement precision, identifying no systematic differences. The study had a power of 93 per cent to detect a clinically important reduction in alveolar cleft width of 5 mm in the sample. There were no statistically significant mean changes in any archform variable between the groups. Lip repair produced a greater change in archform than PSO, reducing the mean alveolar cleft width by 4.45 mm ($P < 0.01$).
CONCLUSIONS: Research into the PSO controversy has become more refined but current investigations are still limited by surgical factors that are overcome in this study. Limitations include the retrospective design and unbalanced sample sizes. The results of this study raise questions for its continued use in this context. Lip repair had a greater impact on arch dimensions than PSO treatment.

95 EFFECTS OF FLUOROSIS AND BLEACHING ON SHEAR BOND STRENGTH OF BRACKETS

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AIM: To evaluate, *in vitro,* the effects of fluorosis and bleaching on the shear bond strength (SBS) of orthodontic brackets.

MATERIALS AND METHOD: Forty-five extracted human premolar teeth randomly divided into three groups. Groups 1 and 2 each comprised 15 teeth with fluorosis (Thylstrup and Fejerskov index score of 4); the teeth in group 2 were bleached with a 35 per cent hydrogen peroxide office bleaching agent, while group 3, in which no bleaching procedure was undertaken, served as the control. Orthodontic brackets were bonded with a light cure composite resin and cured with a halogen light. After bonding, SBS was tested with a Universal testing machine.
RESULTS: Fluorosis and bleaching significantly reduced SBS. Although bleaching of fluorosed teeth decreased the values more, no statistically significant difference was found between groups 1 and 2.
CONCLUSIONS: Under the conditions of this investigation, fluorosis and bleaching procedures significantly affected bonding of orthodontic brackets on human enamel. Bleaching procedures should be delayed until the completion of orthodontic treatment.

96 EVALUATION OF THREE-DIMENSIONAL TOOTH CROWN SIZE IN CLEFT LIP AND PALATE PATIENTS
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AIM: To extensively evaluate three-dimensional (3D) tooth crown sizes in a group of cleft lip and palate (CLP) patients, and compare them with those of a Class I control group.
MATERIALS AND METHOD: Study models of 72 CLP individuals [20 bilateral (BCLP), 34 unilateral left (ULCLP), 18 unilateral right (URCLP)] and 53 Class I adolescents in the permanent dentition stage. Mesio-distal (MD), labio-lingual (LL) and occluso-gingival (OG) measurements were recorded by the same examiner using a digital calliper. Statistical analysis was conducted, including repeatability, analysis of variance (ANOVA), and Duncan's tests.
RESULTS: Upper and lower premolar MD dimensions were larger in the CLP groups than in the control group. The smallest MD dimensions were those of the upper right lateral incisors in the BCLP group ($P < 0.05$). The upper left lateral incisor MD dimensions in the ULCLP group were smaller when compared with the other CLP groups ($P < 0.001$). In general, all LL and OG measurements were smaller in the CLP groups than in the Class I group in both the upper and lower dental arches. In general, MD, LL and OG dimensions of CLP individuals were smaller than those of Class I individuals, not only in the affected upper dental arch, but also in the lower dental arch. Variations in 3D tooth dimensions were found among the CLP types (BCLP, ULCLP and URCLP). The lateral incisor in the cleft region was the most reduced in size.
CONCLUSION: A 3D tooth-size evaluation should be included among the diagnostic records in order to determine precise treatment planning and final occlusion in CLP patients.

97 LONG-TERM CONDITIONS OF IMPACTED MAXILLARY CANINES AFTER ORTHODONTIC TREATMENT
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AIM: To evaluate the long-term conditions of impacted maxillary canines with a follow-up period of 3.2 years (range 2.2-5.7 years) after active orthodontic treatment.
SUBJECTS AND METHOD: Ten orthodontic patients (mean age of 16.6 ± 3.2 years). The impacted maxillary canines (n = 10) had been surgically exposed and treated with fixed edgewise mechanics using light forces. The canines on the opposite side of the dental arch were used as the control group (n = 9). Roentgenographic records were obtained, periodontal conditions were clinically examined, and vitality testing was carried out. The difference between the treatment and the control groups were evaluated using Wilcoxon's signed rank and paired comparison *t*-tests.
RESULTS: The buccal and distal gingival index difference was significant between the groups ($P < 0.05$, $P < 0.01$, respectively), as were the mesial and distal pocket depths ($P < 0.05$). The treatment group showed increased mesial and distal pocket depths (3 ± 1.2 mm, 3 ± 1.9 mm, respectively) when compared with the control group (2 ± 0.7 mm, 2 ± 0.5 mm, respectively). Vitality, percussion and mobility testing showed no statistically significant differences between sides with normally erupted or orthodontically erupted canines.
CONCLUSION: Long-term follow-up of impacted maxillary canines revealed a healthy aspect, with the exception of mesial and distal pocket depths, which were increased when compared with the control group.

98 LANDMARK IDENTIFICATION WITH DIFFERENT CEPHALOGRAM CAPTURE METHODS
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AIM: This retrospective cephalometric analysis compared the repeatability of landmark identification using cephalograms converted from analogue to digital format with two methods: a scanner and two digital cameras. The aim was to determine whether camera capture is a satisfactory substitute for a flatbed scanner, and which camera might perform best.

MATERIALS AND METHOD: Forty randomly selected lateral cephalometric radiographs taken from previously treated orthodontic patient records. The films were scanned using an Epson Expression 1680 Pro flatbed scanner. They were also photographed on a vertically positioned view box using tripod mounted cameras (Nikon Coolpix 4500 and Fuji FinePix S2 Pro). All images were digitised twice by one operator (KA) using the Dolphin™ imaging program. The *X* and *Y* co-ordinates for all landmarks were generated and statistical analyses (Bland-Altman and Lin's coefficient of concordance) used to assess landmark identification repeatability for each method of image capture. Software and scanner accuracy was verified and lens distortion assessed using a calibrated etched glass optical grid.
RESULTS: Landmark identification was repeatable for menton, lower incisor tip, PNS, nose tip, and soft tissue menton on images from both the digital cameras and the scanner. There was a statistically significant difference for nasion identification on Nikon images on the *Y* axis with $P < 0.001$ with a 95 per cent limits of agreement ranging between –4.213 to 3.238 in comparison with the scanner's LOA (–2.318 to 1.883). The upper lip also showed statistically significant difference in identification on the *X* axis using the Fuji FinePix S2 Pro images. The 95 per cent limit of agreements ranged between –2.299 to 3.194 in comparison with the scanner (–1.815 to 1.635).
CONCLUSIONS: Digital cameras can be used as a substitute for a flatbed scanner in transforming analogue cephalograms into a digital format for clinical rather than research purposes. Camera orientation and lens optics can affect image distortion. Care should be taken to determine how digital camera settings affect image quality and ultimately accuracy and reliability.

99 DRY AND STEAM HEAT STERILIZATION AND FORCE CHARACTERISTICS OF NICKEL TITANIUM WIRES

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AIM: Arch wires made of nickel titanium (NiTi) alloys have gained substantial popularity for clinical application. The desirable mechanical properties of NiTi wires and their relatively high cost have prompted many clinicians to recycle these wires. The purpose of this investigation was to determine the effect of steam and dry heat sterilization on the load deflection characteristics of three NiTi wires.
MATERIALS AND METHOD: Twenty 0.016 inch austenitic NiTi alloy from three types of archwires: Force 1 (American Orthodontics, USA), Rematitan lite (Dentaurum, Germany), G&H (G&H, USA) were subjected to a three point bending test to determine their load deflection characteristic before sterilization. For each type of wire 10 samples were sterilized by dry heat (160 degrees, 120 minutes) and 10 by steam heat (121 degrees, 15 psi, 24 minutes). All sterilized samples were also subjected to a three point bending test. Statistical analysis for comparing the properties of the wires before and after sterilization was carried out using ANOVA and Duncan's test at the significance level of $P < 0.05$.
RESULTS: There were significant changes in the load deflection characteristic of wires subjected to sterilization, especially dry heat sterilization. These changes included a reduction in loading and unloading force and a tendency to lose some superelastic properties. Superelastic NiTi wires undergo phase changes as a result of heat treatment that substantially alters their properties. Temperatures greater than 60 degrees can alter the crystalline structure of A-NiTi wires and therefore the mechanical properties.
CONCLUSION: Dry heat and steam sterilization can significantly affect deflection characteristics of NiTi wires.

100 USE OF THE CERVICAL VERTEBRAE MATURATION METHOD IN GROWTH SPURT DETERMINATION

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AIM: To establish the validity of the cervical vertebra maturation (CVM) method as an indicator of skeletal age within the circumpubertal period by correlating the CVM method with the hand-wrist maturation (HWM) method.
MATERIALS AND METHOD: Four hundred hand-wrist and lateral cephalometric radiographs of southern Chinese subjects randomly selected and immediately analysed. The age range for females was between 10 and 15 years, and for males between 12 and 17 years, so that they were during the circumpubertal period. CVM was assessed using the method developed by Baccetti *et al*. (2005) and HWM using two methods, one developed by Hägg and Taranger (1980), and the other by Fishman (1982). They were correlated using Spearman rank correlation analysis.
RESULT: CVM was significantly correlated with hand-wrist skeletal age (Spearman r: male = 0.9521, female = 0.9408) with Hägg and Taranger's method and with Fishman's method (Spearman r: male = 0.9206, female = 0.9363). The method error was insignificant. For the Hägg and Taranger method, all the patients in CVM stage 3 were found to be in the MP3-FG or MP-3G stages of HWM, but with Fishman's method, all patients in CVM stage 3 were in the SMI2 or SMI3 stages of HWM, which were, for both, near the peak of the growth spurt.
CONCLUSION: As the CVM method has a high correlation with HWM in both methods for the southern Chinese population, lateral radiographs can be used to replace hand-wrist radiographs for determination of skeletal maturity to avoid

extra radiation. CVS stage 3 can be used as the maturation indicator to start functional appliance therapy for maximal growth response.

101 COMPARISON OF STABILITY BETWEEN SURGICALLY ASSISTED AND ORTHOPAEDIC RAPID MAXILLARY EXPANSION

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AIM: To investigate and compare the long-term skeletal responses of orthopaedic and surgically assisted rapid maxillary expansion (SARME).
SUBJECTS AND METHOD: Thirty patients divided into three equal groups. The first group (6 males, 4 females; mean age, 15.51 years) were treated by orthopaedic RME, the second group (7 males, 3 females; average age: 19.01 years) by SARME, while the third group (6 males, 4 females; mean age 16.02 years) formed the untreated control group. The cephalograms of the patients in the control group were obtained from the longitudinal study material at the archives of the Department of Orthodontics, Ankara University. All treated patients underwent maxillary expansion with occlusal-coverage Hyrax-type expanders activated twice a day (0.25 mm per turn). The expander was kept on the teeth as a passive retainer for an average period of approximately 3 months. Immediately after expander removal, fixed straightwire appliances were placed. Lateral and posteroanterior cephalograms were obtained for each patient pre-expansion (T1), post-expansion (T2) and three years after expansion removal (T3). Analysis of variance (ANOVA) and Duncan's tests were used to compare the cephalometric measurements of the patients at T1, T2 and T3. Paired *t*-tests were also performed to analyse changes within the observation periods.
RESULTS: Statistically significant differences were found between the SARME and RME groups in N-ANS, SN/PP ($P < 0.01$) and SNA, SNB, mandibular dentoalveolar width (LmolR-LmolL; greater in RME), and tipping of the maxillary bony base (MxR/cg/MxL; greater in SARME) ($P < 0.05$) measurements at the end of expansion (T1-T2). As all patients were treated with fixed appliances following maxillary expansion, only the skeletal parameters were evaluated at T3. The achieved increase in maxillary bony width (MxR-MxL) was reduced slightly (non-significant) in both expansion groups; the amount of relapse was also not statistically significant.
CONCLUSION: Clinically, there is no difference in patient response and long-term results in RME and SARME treated subjects. The only difference between the groups was their indication for RME or SARME, which was based on age and skeletal maturation.

102 SOFT PALATE MORPHOLOGY AND NASOPHARYNGEAL AIRWAY IN CLASS III MALOCCLUSIONS

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AIM: To evaluate and compare the soft palate morphology and nasopharyngeal airway relationship of patients with skeletal Class III malocclusions originating from maxillary retrusion, mandibular protrusion, or a combination of maxillary retrusion and mandibular protrusion.
MATERIALS AND METHOD: Lateral cephalometric radiographs of 66 subjects divided into three groups according to Nperp-A and Nperp-Pg variables; group 1, maxillary retrusion (n = 23; mean age: 13.44 years), group 2, mandibular protrusion (n = 22; mean age: 13.31 years) and group 3, a combination of maxillary retrusion and mandibular protrusion (n = 21; mean age: 13.04 years). Besides the descriptive parameters related to the skeletal origin of the Class III malocclusion, the angulation (ANS.PNS.SPT), length (PNS-SPT) and thickness (SPC-SPD) of the soft palate (PNS-SPT), superior (PNS-PPW1) and inferior (SPT-PPW2) pharyngeal spaces and the ratios of soft palate length and supero-inferior pharyngeal spaces (SPL/SPS and SPL/IPS) were evaluated. The differences between the groups were evaluated using analysis of variance (ANOVA) and Duncan's test.
RESULTS: Significant differences in the craniofacial structures were observed between all three groups for Nperp-A and SNB ($P < 0.001$); group 1 and groups 2 and 3 in Nperp-Pg ($P < 0.001$); group 2 and groups 1 and 3 in SNA ($P< 0.001$); groups 2 and 3 in ANB ($P < 0.001$). The angulation of the soft palate (ANS.PNS.SPT) was similar between all groups. Significant differences in nasopharyngeal relationships were observed between groups 2 and 3 in the ratio of soft palate length and inferior pharyngeal space (SPL/IPS; $P < 0.001$), inferior pharyngeal space (SPT-PPW2; $P < 0.01$) and the ratio of soft palate length and superior pharyngeal space (SPL/SPS; $P < 0.05$).
CONCLUSION: The pharyngeal airway dimensions were greater and the soft palate length shorter in patients with prognathic mandibles (group 2), followed by maxillary retrusion and maxillary retrusion combined with mandibular protrusion patients. This morphological and functional characteristic of skeletal Class III patients with prognathic mandibles may result in a higher tendency to articulatory speech disorders.

103 IS THE DEVELOPMENT OF A FISTULA IN SECONDARY PALATE OPERATOR-INDUCED?

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AIM: To assess whether cleft severity, age at repair, and the experience of the operating surgeon contribute to the development of fistula in patients with cleft of the secondary palate.
SUBJECTS AND METHOD: Eight hundred and seventy six individuals born between 1960 and 2002 with a cleft of the secondary palate who had their primary surgery performed at the National Hospital using a modified von Langenbeck technique. Data were collected retrospectively from the archives of the Oslo Cleft Team.
RESULTS: Three-hundred-and-eighty-three patients were boys. A palatal fistula developed in 52 patients (5.9%). Patients with a total cleft of the palate more often developed a fistula than those with a cleft of the soft palate (16.5 versus 3.1%, $P < 0.001$). Patients with a submucous cleft palate developed a fistulae significantly more often than those with a soft palate (7.0 versus 3.1%, $P = 0.040$). Among patients with a total cleft of the palate, those who had primary surgery later than 18 months of age were more likely to develop fistula than children who underwent surgery before the age of 12 months (28.6 versus 4.8%, $P = 0.038$). In each cleft severity subgroup, the fistula incidence decreased significantly with increasing experience of the operating surgeon. Fistula incidence was not related to gender in any of the subgroups.
CONCLUSION: Development of fistulae was significantly related to cleft severity and the experience of the surgeons. Among patients with a total cleft palate, it was also related to age at the time of primary surgery.

104 SURFACE AND BENDING PROPERTIES OF ORTHODONTIC NiTi ARCHWIRES

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AIM: Orthodontic appliances should not only meet the requirement of functionality, but should also be aesthetically sound. In the field of superelastic NiTi arch/straightwires, synthetic coatings seem to meet both requirements, promising prevention of nickel ion release and reduced friction, as well as a more 'natural' look. The aim of this study was to investigate the mechanical properties of the wires and the surface state of the coatings after *in vivo* orthodontic treatment of 12 weeks.
MATERIALS AND METHOD: Uncoated and corresponding coated NiTi archwires with the dimensions 0.016, 0.018, 0.016×0.016 inch, from four different suppliers used in the treatment of 14 adolescents. Three-point-bending tests were performed on 2 cm segments of the retrieved straight ends of the wires using a material testing machine (Synergie 200, MTS) with an integrated load gauge of 10 N at 38°C. Each data set included two loading cycles. The appearance of the surface was investigated via light microscopy (Motic, Stereomicroscope DMW 143 FBGG-B).
RESULT: All wires tested exhibited excellent superelasticity. Compared with samples in the as received state, only minor differences were found in mechanical parameters such as the elastic bending modulus, and the load and unloaded plateau forces. Except for one brand, differences in these parameters were found for uncoated and the corresponding coated products. Light microscopy showed slight to severe damages of the surface, especially in the slot region. For numerous coated specimens, the coating was completely removed in this region.
CONCLUSION: Synthetic coatings do not affect the superelasticity of NiTi archwires. The mechanical resistance of the coatings to wear seems to be low. The coatings are damaged during orthodontic treatment, and could have little effect on the wear behaviour of the wires. The desirable aesthetic effect is also gradually lost during orthodontic treatment. The risk of up-take of the polymer fragments should also be considered.

105 SELF-APPLIED HYGIENE EFFICACY IN PATIENTS WEARING FIXED ORTHODONTIC APPLIANCES

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AIM: Improved hygiene techniques and chemotherapeutics may assist orthodontic patients in maintaining their oral health during therapy. This study examined the efficacy of different designed toothbrushes and interdental cleaning brushes.
SUBJECTS AND METHOD: Orthodontic patients with fixed appliances. Plaque was disclosed with fluorescein and a pre-brushing DPIA plaque image was taken. The subjects were then assigned to one of four brushing treatment: V1 (Oral B® P35 manual brushing – timed/supervised for 40 seconds); V2 (Oral B® P35 manual brushing – followed by an Oral B® interdental brush – standard head); V3 (Oral® B orthodontic brush manual brushing); V4 (Oral B® orthodontic brush manual brushing followed by Oral B® interdental brush - standard head). Following brushing, the subjects were re-disclosed with fluorescein and a post-brushing image was taken.
RESULTS: All self-applied hygiene regimens were effective in removing significant quantities of plaque from the dentition of orthodontic patients (pre- versus post-brushing, $P < 0.05$). Plaque removal was assessed as the percentage of tooth area

cleaned during brushing. Plaque removed ± SD measured for each of treatment group were as follow: V4 (n~13) = 31.0 (±11.0)a; V3 (n~15) = 22.5 (± 12.1)ab; V2 (n~13) = 25.9 (± 13.3)a; V1 (n~12) = 16.5 (± 9.1)b (a≠b at $P < 0.05$ Student's paired *t*-test).
CONCLUSIONS: The orthodontic toothbrush and the interdental cleaners increased the ability of patients to remove dental plaque. Products developed for specialized cleaning of fixed appliances (orthodontic brush and interdental brush) were more effective than brushing with a standard manual brush alone. Further studies are needed to assess long-term implications of improved brushing efficiency in orthodontic patients and strategies to improve compliance with improved hygiene implements.

106 COMPARISON OF ORTHODONTIC TREATMENT, CORTICOTOMY AND ANTERIOR SEGMENTAL OSTEOTOMY FOR LIP PROTRUSION

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AIM: To compare outcomes of orthodontic treatment (OT), anterior segmental osteotomy (ASO), and corticotomy-assisted orthodontic treatment (CAO) for resolution of bimaxillary dentoalveolar protrusion.
SUBJECTS AND METHOD: Sixty-five adult Korean female patients with bimaxillary protrusion with a good treatment result were divided into groups. Group 1 (OT), group 2 (CAO with skeletal anchorage in the maxilla and ASO in the mandible), and group 3 (ASO in the maxilla and mandible). The hard and soft tissue variables were measured from lateral cephalogram tracings at the pre- (T0) and post- (T1) treatment stages. Statistical analyses were carried out to compare difference at T0, and the changes during T0-T1.
RESULTS: The greatest amount of basal bone retraction, and the least amount of upper incisor inclination change and upper alveolar bone bending was found in group 3. The amount of change in upper lip projection and angulation were greater in group 2 than in group 1. Group 3 showed a decrease of upper incisor exposure, whereas group 1 showed an increase. U1-FH, upper and lower alveolar ridge angle, Pog-N perpendicular, and APDI were selected as significant variables for discriminating the three groups.
CONCLUSIONS: OT or CAO is indicated for those with severe incisor proclination with normal basal bone position, although CAO may be advantageous for adult patients concerned about treatment duration. ASO is recommended for bimaxillary dentoalveolar protrusion patients with a 'gummy' smile, basal bone prognathism, relatively normal incisor inclination, and a relatively underdeveloped chin position.

107 INFLUENCE OF ORTHODONTIC EXTRUSION ON PULP VITALITY OF TRAUMATIZED TEETH

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AIM: To investigate the influence of orthodontic extrusion on pulp vitality of previously traumatized permanent upper incisors.
SUBJECTS AND METHOD: Seventy-six patients with 98 traumatized teeth belonging to the following categories: fracture of enamel (n = 15), fracture of enamel-dentine (n = 20), subluxation (n = 14), extrusive or lateral luxation (n = 24) and intrusion (n = 25). The control group included 100 patients with 400 upper incisors with no clinical or radiographic signs and no history of dental trauma. Inclusion criteria were: positive sensitivity testing, anterior open bite, treatment with a utility type archwire to extrude the upper incisors, and no additional lateral tooth movement of the incisors.
RESULTS: Pulp necrosis was determined in 6.7 per cent of the teeth with enamel fracture, in 5.0 per cent of the teeth with a fracture of the enamel-dentine, in 14.3 per cent following subluxation, in 37.5 per cent after extrusive or lateral luxation, and in 32.0 per cent after intrusion injury. Significant differences were determined between the control group (1.0 per cent), and teeth after subluxation ($P = 0.044$), luxation ($P < 0.001$) or intrusion ($P < 0.001$) injuries.
CONCLUSIONS: Extrusion of previously traumatized teeth with periodontal injury has a detrimental effect on pulp vitality.

108 RESULTS OF AUTOTRANSPLANTATION OF IMMATURE THIRD MOLARS

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AIM: To determine the effect of restorations on pulp vitality of autotransplanted immature third molars.
SUBJECTS AND METHOD: Thirty-seven patients (21 females, 16 males) with a total of 38 transplanted immature third molars. The mean age of the patients at the time of transplantation was 17.6 years (range 16.1-20.3 years). The average follow-up period for all teeth was 3.8 years (1.0-7.1 years). For all 37 transplants, occlusal caries was detected during the

final follow-up. A dark discolouration was seen in 16 transplants (42%), and decalcification was diagnosed in 10 transplants (26%). A visible cavitation of the enamel surface with sticking of the probe was found in 12 transplanted teeth (32%).
RESULTS: Extended fissure sealing without dentine exposure was carried out in 22 transplants. In the remaining 16 teeth, dentine was exposed during caries excavation. In these cases, Class 1 occlusal fillings were performed after application of a dentine adhesive. One year after the restorations, all transplants with extended fissure sealing revealed a positive reaction to sensitivity testing. In contrast, pulp necrosis was determined in four of the transplants (25%) with dentine exposure during caries excavation, the difference being statistically significant ($P = 0.025$).
CONCLUSIONS: Caries excavation with exposure of dentine seems to increase the risk of pulp necrosis in autotransplanted teeth. Early intervention, probably in combination with prophylactic fissure sealing, is recommended.

109 EPITHELIAL RESTS OF MALASSEZ IN THE HUMAN PERIODONTAL MEMBRANE

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AIM: To describe the localisation and extension of epithelial rests of Malassez (ERM) in the periodontal membrane (PDM) of normal human third molars.
MATERIALS AND METHOD: Twenty-four normally developed human third molars surgically removed from patients prior to orthognathic surgery. The age range was from 15-27 years (6 females, 6 males). The root lengths were developed from close to half-length, to complete root closure. Extracted teeth were fixed in 10 per cent neutral buffed formalin, decalcified in EDTA and paraffin embedded. Immunohistochemistry was performed using polyclonal rabbit anti-bovine cytokeratin (wide spectrum screening) and EnVision+ dual link system.
RESULTS: ERM cells were distributed in the PDM in a network along the root surface.
CONCLUSION: ERM cells have earlier been described mainly in animal experimental studies. Only a few case studies have described the occurrence of ERM in human PDM. This ectodermal tissue layer might influence not only the morphology of the tooth, but also tooth eruption. The reaction of this epithelial layer in connection with ankylosis and orthodontic tooth movement may be of importance.

110 STEPWISE ADVANCEMENT VERSUS MAXIMUM JUMPING WITH THE HEADGEAR ACTIVATOR

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AIM: To compare the effects of stepwise mandibular advancement versus maximum jumping, and extended treatment versus early retention.
MATERIALS AND METHOD: The material was obtained prospectively and consisted of lateral cephalograms taken at the start (T0), after initial (T1), and at the end (T2) of treatment, from two groups of consecutively treated skeletal Class II patients who had undergone therapy with headgear activators. The first headgear activator group, HGA-S (n = 24; mean age 11.9 ± 1.2 years) was treated for 13 months and had 4 mm mandibular advancement every 3 months. The second headgear activator group, HGA-M (n = 31; mean age 11.2 ± 1.5 years), had maximum jumping, 6-8 mm interincisal opening, for a total of 15.4 months, and with reduced wear for the last 6.9 months. The dropout over 12 months was 41 and 46 per cent, respectively. Pre-treatment growth changes were obtained as reference. The lateral cephalograms were analysed using the SO-method (Pancherz, 1982).
RESULTS: Both groups showed enhanced mandibular prognathism during the initial phase (T0-T1), followed by normal growth (T1-T2). Lower face height was enhanced throughout treatment (T0-T2). In both groups the mandibular plane and occlusal angles increased, possibly enhanced by ‘extrusion’ of the lower molars. In both groups maxillary forward growth was restrained only during the initial phase, but the effect remained significant at T2 for the HGA-S group. In the HGA-M group, the lower incisors were protruded, while in the HGA-S group they were unaffected.
CONCLUSION: Both modes of mandibular jumping resulted in skeletal and dental effects. The length of active treatment seems to be decisive in maintaining treatment effects, with stepwise advancement having less dental effects.

111 CHILD PERCEPTION QUESTIONNAIRE RELATED TO SELF-ASSESSED AND CLINICAL FEATURES IN CHILDREN WITH MALOCCLUSION

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AIM: To examine the relationship between the oral health related quality of life of children with malocclusions as measured with the Child Perception Questionnaire (CPQ11-14) and self-assessed and clinical orthodontic features.

SUBJECTS AND METHOD: This was a cross-sectional study carried out at the Orthodontic Department at the Charles Clifford Dental Hospital, Sheffield and the Chesterfield and North Derbyshire Royal Hospital, Chesterfield. The children, aged 11 to 14 years, were in Index of Orthodontic Treatment Need (IOTN) Dental Health Component (DHC) groups 4 or 5 due to crowding (4d), increased overjet (4a or 5a) or hypodontia (4h or 5h). They were asked to independently complete the CPQ11-14 questionnaire as well as rate satisfaction with their dental appearance and score their teeth using the IOTN aesthetic component (AC) chart. They were also asked if their main concern was whether their teeth were crooked (crowding), 'goofy' (overjet) or 'gappy' (hypodontia). The clinical orthodontic measures included clinician-assessed AC, IOTN DHC, size of overjet (mm) and degree of crowding/spacing. The associations between the CPQ11-14 as the dependent variable and clinical and child-perceived measures as the independent variables were assessed using multiple linear regression analysis.
RESULTS: One hundred children completed the study, including 46 in IOTN DHC 4d, 34 in 4a or 5a and 20 in 4h or 5h. Child-rating grouping was correlated with total CPQ11-14 ($r = 0.186$; $P = 0.032$) and social well being ($r = 0.197$; $P = 0.025$); those children with increased overjet having the highest total CPQ11-14 score. Dissatisfaction with dental appearance was correlated with total CPQ11-14 ($r = 0.343$; $P < 0.01$), emotional ($r = 0.370$; $P < 0.01$) and social ($r = 0.290$; $P < 0.01$) well-being. However, only satisfaction with dental appearance showed a statistical significance ($P < 0.01$) in the multiple linear regression and accounted for 17.3, 18.9, and 15.7 per cent variances of total CPQ11-14, emotional and social well-being, respectively. None of the clinical orthodontic features showed a statistically significant association with the CPQ11-14 results.
CONCLUSIONS: Higher dissatisfaction with dental appearance is related to a higher CPQ11-14 score. Adolescents with increased overjets tended to have higher CPQ11-14 scores, but the CPQ11-14 scores were not explained by any other clinical orthodontic feature.

112 TENSILE STRENGTH OF DIFFERENT SOLDERING AND WELDING METHODS

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AIM: As controversy exists concerning the use of conventional soldering techniques because of low biocompatibility and high corrosion, laser and micro-impulse welding were developed for orthodontic purposes. The aim of this study was to compare optimal welding conditions with micro-impulse welding with laser welding and conventional soldering methods.
MATERIALS AND METHOD: Five different orthodontic joint configurations with two different diameters (0.9/1.2 mm) were used: edge-to-edge, criss-cross, half round, 3 and 10 mm length (n = 10). The joints were made by five different methods: soldering with universal silver solder, Orthophaser (Dentaurum), welder (Schütz Dental), DL 2002 (Dentaurum) and LWI (Schütz Dental). The tensile strength measurement was carried out with a universal testing machine (Zwick 005). Data were analyzed with ANOVA ($P = 0.05$) and Bonferroni's *post hoc* test.
RESULTS: In all cases soldering joints were ruptured at a low level of tensile strength. Welding joints broke in the heat affected zone. There were statistically significant differences between soldering and welding ($P < 0.05$). For the 3 mm samples the value for soldering with a force of 379 N, was remarkably low. For the welded samples the mean values were between 492 and 655 N. A slight tendency to higher mean values and lower standard deviations were an indication of improved joining quality with laser welding.
CONCLUSION: The new micro-impulse welder is comparable with the laser welding method and is an interesting low cost, solder-free alternative for orthodontic purposes.

113 CRANIOMANDIBULAR DYSFUNCTION AFTER COMBINED ORTHODONTIC ORTHOGNATHIC SURGERY

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AIM: To evaluate the temporomandibular function of patients after orthognathic surgery with the Helkimo index (D 0-III) compared with a normal population.
SUBJECTS AND METHOD: Craniomandibular dysfunctions (CMD) were evaluated with the Helkimo index (D 0-III) in a group of patients (n = 105, F = 69, M = 36) after osteotomies. The average follow-up time was 47 months (9-141 months). The osteotomies performed were: 58 bilateral sagittal split, 12 Le Fort I, 22 bimaxillary and 13 segmental osteotomies. A control group (n = 107, F = 97, M = 60, age 20-39 years) was examined in an epidemiological study. Statistical analysis was performed using the Statistical Package for Social Sciences (Windows, 10.0).
RESULT: For 82.8 per cent of the patients no symptoms or mild dysfunction were found. Comparison between the patient (31.4%) and control (31.7%) groups revealed a similar frequency. The most frequent dysfunction was reduced mandibular mobility, which determined the statistical significance ($P < 0.05$) between the patients and the control group for the

dysfunction group D II and D III. The chi-square test did not show any difference between gender and type of osteotomy with regard to dysfunction.
CONCLUSION: Most of the patients showed no or mild symptoms of CMD an average of 47 months after orthognathic surgery (D0, D-I). In comparison with a representative population group, no significant frequencies of CMD (D0-III) were found. In the patient group mild reduced mandibular mobility could be demonstrated. In the post-operative treatment procedure better functional management to improve mandibular mobility is necessary.

114 STABILITY OF CLASS II DIVISION 2 TREATMENT WITH THE HERBST APPLIANCE

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AIM: To retrospectively analyse and compare the treatment and post-treatment effects of adolescent and adult Class II division 2 Herbst treatment.
SUBJECTS AND METHOD: Thirty-five Class II division 2 subjects exhibiting a Class II molar relationship ≥0.5 cusp bilaterally or ≥1.0 cusp unilaterally, and an overbite >3.0 mm. According to their skeletal maturity, the subjects were divided into three groups: pre-peak (n = 11), post-peak (n = 11), end of growth (n = 13). Herbst treatment was performed for an average period of 7.5 months followed by an average multibracket phase of 11.0 months. Lateral cephalograms from before (T1), and after Herbst (T2) treatment, after Herbst and multibracket appliance treatment (T3), and after an average retention time of 28 months (T4) were analyzed using the SO-analysis and standard cephalometrics.
RESULTS: During Herbst treatment (T2-T1), Class II molar correction amounted to 7.0 mm in the pre-peak group, 6.0 mm in the post-peak group and 4.9 mm in the end of growth group. In the pre-peak and end of growth groups, molar correction was achieved by 33 per cent skeletal and 67 per cent dental change, while in the post-peak group, 48 per cent skeletal and 52 per cent dental change was found. During the multibracket-phase (T3-T2), a molar relationship recovery occurred in all three groups (pre-peak: 2.5 mm; post-peak: 2.7 mm; end of growth: 1.9 mm), which was due to dental changes only. During the retention period (T4-T3), all three groups showed a slight relapse of the molar relationship (pre-peak: 0.1 mm; post-peak: 0.3 mm; end of growth: 0.2 mm). In the pre- and post-peak groups it comprised only dental changes, while only skeletal changes were seen in the end of growth group.
CONCLUSION: Class II division 2 Herbst treatment shows favourable long-term stability independent of skeletal maturity. However, treatment in the pre-peak and end of growth groups resulted in less skeletal effects than treatment in the post-peak group.

115 DETERMINATION OF THE ACTUAL CROSS-SECTIONAL DIMENSIONS OF NICKEL TITANIUM ARCHWIRES

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AIM: To define and compare the actual cross-sectional dimensions of 10 representative 0.43 × 0.64 mm (0.017 × 0.025 inch) NiTi archwires, and to compare them with their nominal values.
MATERIALS AND METHOD: Ten upper 0.017 × 0.025 inch NiTi archwires were selected: Nitinol® Classic, SE and HA (3M Unitek), Neosentalloy® 100 and 200 g (GAC), Copper NiTi® 27°C, 35°C and 40°C (Ormco), Rematitan Lite®, Rematitan Lite White® (coated version) (Dentaurum) and compared with a multi-braided stainless steel wire (D-Rect®, Ormco). Duplicate measurements of the occluso-gingival and bucco-lingual dimensions were taken at three different locations (mid-point and two points distal to the upper left and right first molars) on 30 specimens of each wire type using a Mitutoyo digital calliper (accurate to ±0.01 mm) coupled with specific software (Mohr, 2000).
RESULTS: Kolmogorov tests showed that the measurements for each wire type followed a normal distribution ($P > 0.05$). A single factor ANOVA was successively performed for height and width. The null hypothesis that all mean dimensions were equal among the different wire types was rejected. Tukey tests revealed that the mean heights of D-Rect and Rematitan Lite White were significantly larger compared with the mean of all other wires, whereas the mean height of Copper NiTi 40°C was smaller. Most mean widths differed significantly from each other. On average, NiTi archwires were significantly undersized ($P < 0.001$) in height (deviation from nominal value of –5.3% for Copper NiTi 40°C) and width (–5.4% for Copper NiTi 27°C). Rematitan Lite White was the exception to this rule with a mean height comparable with the nominal value and a width significantly increased (+9.3%). Copper NiTi 40°C displayed the highest standard deviation for height (1.7%), and Rematitan Lite White for width (3.1%). With respect to height, only Rematitan Lite White appeared to conform to the 2006 ISO 15841 norm for orthodontic wires. The widths of Copper NiTi and Rematitan seemed not to comply with the stated norm. D-Rect archwires were significantly thicker anteriorly compared with the posterior reference points (+5.7%), whereas Neosentalloy 100 (+5.2%) and 200 g (+4.7%) and Rematitan Lite White (+4.6%) wires were broader anteriorly.

CONCLUSION: NiTi archwires appear to be consistently undersized in both height and width. These reduced cross-sections combined with often oversized bracket slots, significantly undermine the three-dimensional control of tooth movement.

116 FACIAL MORPHOLOGY OF UNILATERAL CLEFT LIP AND PALATE SUBJECTS AT 6 AND 15 YEARS OF AGE

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AIM: A longitudinal study of craniofacial morphology and soft tissue profile at 6 and 15 years of age in children with unilateral cleft lip and palate (UCLP) to evaluate whether there are differences between two groups operated using different cleft lip and palate (CLP) repair protocols, the pushback (PB) or von Langenbeck (VL) technique.
SUBJECTS AND METHOD: Sixty-two UCLP children. Two groups were compared: 31 (21 boys, 10 girls) subjects had hard palate closure with the PB technique (born before 1986) and 31 (25 boys, 6 girls) underwent surgery using the VL technique (born after 1986). Surgery was carried out at the Department of Plastic and Reconstructive Surgery, Haukeland University Hospital, Bergen. Lateral cephalograms at 6 and 15 years of age were collected from the CLP archive, and digitized by two investigators, using the mean values for statistical analysis. Inclusion criterion: consecutive complete UCLP cases. Exclusion criteria: foreign ethnicity, congenital syndromic anomalies, and lateral cephalograms of unacceptable quality. Gender differences were not considered since only angular and ratio variables were used.
RESULTS: A significant skeletal difference was found between the two groups with a larger anterior face height ratio (76%) in the VL group ($P = 0.010$), indicating a more normal relationship between upper and lower face height in this group. In addition, the soft tissue profile was significantly more convex in the VL group ($P = 0.016$), indicating a more favourable profile. Between 6 and 15 years of age all variables showed significant differences in both the PB and VL groups.
CONCLUSION: Follow-up studies are vital for quality assurance and quality improvement of CLP treatment. This study indicates that a CLP repair protocol using VL technique results in a more normal anterior face height ratio and a more favourable soft tissue profile compared with PB surgery.

117 CONSISTENCY OF ARCHWIRE DIMENSIONS

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AIM: Optimal orthodontic tooth positioning requires three-dimensional (3D) expression of the prescription generated between the bracket system and wire. Variation in archwire dimension may account for the failure of desired tooth positioning and axial inclination of incisors. The aim of this study was to investigate the consistency of archwire sizes used for torque expression in orthodontic treatment.
MATERIALS AND METHOD: Various dimensions (0.019×0.025, 0.0215×0.028 and 0.016×0.025 inch) rectangular stainless steel, nickel-titanium, titanium molybdenum alloy and copper nickel titanium wires commonly used for the 3D control of teeth in the 0.022×0.028 inch preadjusted straightwire system supplied by different manufactures, (Ormco, Orthocare, Precision Orthodontics, TP Orthodontics, Highland Metals and Ortho Technology). The samples were mounted in resin and sectioned and examined using laser assisted photomicroscopy. Computer assisted image analysis was used to assess width, height, edge bevel and cross-sectional area. The data was subjected to non-parametric statistical analysis.
RESULTS: All samples exhibited dimensional inaccuracies ($P < 0.05$) with all wires being undersized with regard to cross-sectional area. Differences in the measured cross-sectional area and the nominal values ranged from 5 to 16 per cent.
CONCLUSIONS: The orthodontic wires did not conform to the acceptable clinical standards of medical devices. There are inter-manufacture variations and differences with regard to the degree of edge bevel, width, height and therefore cross-sectional area. Clinicians need to be aware that as a result of their use of inconsistent archwire sizes inadvertent loss of desired torque expression may be experienced.

118 CONE BEAM COMPUTED TOMOGRAPHY AND CLINICAL OUTCOMES: HOW CAN IT BE MEASURED IN THREE-DIMENSIONS?

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AIM: Cone beam computed tomography (CBCT) has, due to its low patient effective exposure radiation dose, become a valid alternative to conventional plain radiography in dentistry. Moreover CBCT is capable of depicting the patient's anatomy in three-dimensions without the geometric distortion and limitations inherent with two-dimensional (2D) examinations. These features provide both clinicians and researchers an unprecedented opportunity to analyse treatment outcomes in large

study groups in a truly three-dimensional (3D) way. The aim of this study was to determine how treatment outcomes can be evaluated using CBCT technology.
SUBJECTS AND METHOD: Ten patients, who underwent treatment including expansion of both arches using only self-ligating brackets, were scanned with a CBCT-scanner before and after completion of treatment. The scans were used to evaluate the type of changes that occurred in the dentoalveolar structures as a result of dental displacements. The treatment outcomes were analyzed using two techniques: a) 2D measurement based on the CBCT-scans: from reformatted 3D data-sets frontal axial images were generated in the premolar region and the amount of buccal bone and tooth inclination was calculated. b) 3D measurement on 3D data-sets: 3D models were generated from the scans using a semi-automatic segmentation technique. Stable structures of the cranial base were used to register the pre- and post-treatment 3D models. After registration, a tool allowed the visual and quantitative assessment of post-treatment changes via 3D coloured displacement maps of superimposed models.
RESULTS: With the 2D approach it was possible to evaluate the changes in tooth inclination and the amount of pre- and post-treatment buccal bone. Changes of the upper dentition and the maxillary bone after treatment were better evaluated when the 3D approach was used. With this method, patient specific 3D colour-coded maps of the changes that occurred during treatment both at the dental and skeletal levels could be clearly visualized.
CONCLUSION: The findings confirmed the validity of both methods in depicting the changes that occurred during treatment. However, in order to fully exploit the possibility of CBCT technology in analysing treatment outcomes, clinicians have to be able to localize absolute changes in pre- and post-treatment 3D-models registered on stable cranium structures. For these reason, a 3D approach is the most valuable assessment of changes in the dento-alveolar structures.

119 AUTOTRANSPLANTATION OF TEETH: A SYSTEMATIC REVIEW

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AIM: To review the literature on autotransplantation of teeth with regard to success and failure rate.
MATERIALS AND METHOD: Electronic databases (PubMed, Medline, Embase, Web of Science, EBM) were searched with the help of a health sciences librarian. An electronic search was supplemented by a manual search of reference lists of retrieved articles. Predefined inclusion criteria based on a minimum observation time of 1 year and application of defined criteria for successful transplantation (physiological mobility of the transplant, maximum pocket probing depth –3 mm, no indication of periapical radiolucency or inflammatory root resorption, no ankylosis), were applied to determine the selection of articles.
RESULTS: The search revealed 353 articles. Eligibility of the selected articles was determined by reading their titles or abstracts. Seventy-six full texts were obtained. Twenty-seven articles fulfilled the inclusion criteria. According to these criteria, in clinical studies a survival rate varying from 72 to 100 per cent was reported. The overall success rate varied from 64 to 97 per cent. This review showed an incidence of inflammatory root resorption (0-21%) and an incidence of ankylosis (0-20%). The success rate could be influenced by the type of donor tooth, the developmental stage of the transplants, trauma to the periodontal ligament of transplants, fixation type, orthodontic movement of transplants, and recipient site.
CONCLUSION: There is some evidence that autotransplantation of teeth is a reliable and clinically useful method in oral rehabilitation.

120 UNDERDEVELOPMENT OF THE JAW-OPENING REFLEX AFTER LOW MASTICATORY FUNCTION

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AIM: A number of clinical and animal studies suggest that many developmental processes depend on mechanical stimuli. While decreased masticatory function due to a soft or liquid-diet has been widely accepted to cause a reduction in the growth and development of craniofacial bones and jaw-muscle morphologically, the effects on functional masticatory performance have received less attention and are still unclear. To clarify this, the present study was undertaken to investigate the effects of low masticatory function during growth on the functional development of jaw-muscle activity by determining one of the mastication-related and learning-acquired neurophysiological indices, the jaw-opening reflex (JOR).
MATERIALS AND METHOD: Soon after weaning, 24 female Wistar albino rats were divided into two equal groups and fed either a solid (control group) or a liquid (low masticatory function group) diet. At 13 weeks of age, JOR, recorded in the anterior belly of the digastric muscle and evoked by low-intensity electrical stimulation of the ipsilateral inferior alveolar nerve, was evaluated in anaesthetized rats of both groups. The parameters of the JOR measured were: latency, peak-to-peak amplitude and duration. The values were expressed as mean ± SD then unpaired *t*-tests were used for statistical comparisons between the two groups.
RESULTS: JOR latency was significantly longer ($P < 0.05$) and peak-to-peak amplitude was significantly less ($P < 0.05$) in the low masticatory function group, although the duration was unaffected.

CONCLUSION: Adult rats with induced low masticatory function during growth, showed underdevelopment of the JOR, which might result in impairment of masticatory function. Long-term low masticatory function during growth may impede the motor learning of mastication, leading to inefficient masticatory performance in adults.

121 MASSETER MUSCLE CHARACTERISTICS AND CRANIOFACIAL MORPHOLOGY

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AIM: Different studies have shown that the functional capacity of the masseter muscle, e.g. muscle thickness, or the masseter muscle mechanical advantage, i.e. the orientation of the muscle in relation to the occlusal plane, are associated with craniofacial morphology. However, the possible complementary effect and relationship between these two factors to craniofacial morphology have not previously been studied. The aim of this research was to investigate the relationship between masseter muscle thickness and its mechanical advantage, and the association of these two factors with craniofacial morphology.
SUBJECTS AND METHOD: In 36 females and 36 males, 8.5-9.5 years of age with various malocclusions and no history of previous orthodontic treatment, masseter muscle thickness was measured by means of ultrasonography and the mechanical advantage on lateral cephalograms as the ratio between the masseter moment and the bite force moment arms.
RESULTS: The mean masseter thickness was greater in males than in females. There were no significant gender differences for the mean mechanical advantage or for the measurements of craniofacial morphology. A positive association between masseter muscle thickness and its mechanical advantage was found in females. Moreover, a positive association was found between the mechanical advantage and posterior to anterior face height ratio in both genders. Masseter thickness showed a negative association with the intermaxillary angle in females.
CONCLUSIONS: Individuals with a masseter muscle acting closer to the molars had a hypodivergent craniofacial morphology. The importance of the mechanical advantage and the thickness of the masseter muscle was more evident in females.

122 AN AUDIT TO EXAMINE THE ACCURACY OF A DATABASE FOR HYPODONTIA PATIENTS

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AIM: At Newcastle Dental Hospital a database of hypodontia patients has been developed. Initially patient details were transferred from hospital records directly into the database by research nurses. Since the database is used for audit and research projects it is important that the information is accurate. The aim of this study was to assess the accuracy of patient information stored in the database compared with that stated in the hospital record.
MATERIALS AND METHOD: One hundred patients were selected at random from a computerised list of patients on the hypodontia database. The information which was compared between the database and hospital records included: name, gender, date of birth, family history, medical history, tooth type and the number of missing teeth, as well as an orthodontic assessment comprising the anteroposterior relationship, lower and upper arch alignment, incisor relationship, overjet, overbite and presence of a crossbite. The audit standard set for this investigation was that there should be 100 per cent accuracy between patient records and the database. A re-audit was undertaken 6 months later when a proforma was developed for the clinician to complete at the time of seeing patients so the data could be transferred directly from the proforma rather than hospital records by the research nurses.
RESULTS: The percentage of data correct for each of the variables was determined for the initial audit and for the re-audit. The only variables that were 100 per cent correct in both audits included name, gender and medical history. The results of the re-audit showed that the accuracy of information improved when using the proforma. The percentage correct for number of missing teeth increased from 80 to 92 per cent and for tooth type missing from 86 to 96 per cent. All variables for the orthodontic assessment improved in accuracy. In particular, the percentage correct for overjet increased from 73 to 97 per cent and for overbite from 74 to 94 per cent. However for many variables 100 per cent accuracy was still not achieved.
CONCLUSIONS: A proforma completed by clinicians at the time of examining the hypodontia patients improved the accuracy of the database. However there were still some inaccuracies, which may be due to the input of data. To overcome these problems, a dedicated laptop to directly input data during the clinic could be used. Additionally, in the future, it may be possible to link the database to electronic hospital records.

123 FACTORS INFLUENCING PREDICTION ACCURACY OF ORTHOGNATHIC SURGICAL OUTCOME

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AIM: To retrospectively assess the subjective accuracy of predictions generated by a computer imaging software in Chinese patients who had undergone orthognathic surgery, and to determine the influence of initial dysgnathia and complexity of the surgical procedure on prediction accuracy.
SUBJECTS AND METHOD: Forty Chinese patients who had completed treatment involving orthodontics and orthognathic surgery. All had lateral cephalometric radiographs and profile photographs taken within 3 months before surgery and at least 6 months after surgery. The computer-generated prediction images and the actual post-treatment images were displayed simultaneously to a panel of orthodontists, oral maxillofacial surgeons and laypersons to allow side-by-side comparison. The panel was asked to determine which image was more aesthetic and to rate the likeness between the actual and predicted images using a 10 cm visual analogue scale.
RESULTS: The actual image was judged to be more aesthetic in 82 per cent of the cases, with the orthodontists more likely to select the actual profile compared with laypersons ($P = 0.005$). Orthodontists and surgeons rated the likeness of the images similarly, while laypersons rated the likeness significantly lower than the clinicians ($P = 0.012$ and $P = 0.015$, respectively). Skeletal III cases were judged to be less accurately predicted than Skeletal II cases by laypersons ($P = 0.006$) and orthodontists ($P = 0.036$). Subjects treated by a single-jaw osteotomy were ranked higher compared with those treated with a bimaxillary osteotomy by all panel groups, but the differences did not reach significance.
CONCLUSIONS: Skeletal III cases, managed by bimaxillary osteotomy, were least accurately predicted by the computer program. As there exists a possibility that the predicted image may be judged to be more aesthetic than the actual image, clinicians need to manage patient expectations when using computer simulations for patient education.

124 A COMPARATIVE STUDY OF A NEW FIBRE-REINFORCED COMPOSITE ACRCHWIRE

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AIM: Fibre reinforced polymer archwires (FRPC) provide a good aesthetic solution to conventional orthodontic archwires. A prospective study was undertaken to: 1. Evaluate the effects of friction on the wear characteristics of archwires of various bracket and archwire combinations; 2. Determine if there is correlation between surface roughness and friction of the archwires and 3. Compare the performance of FRPC wire with NiTi wires.
MATERIALS AND METHOD: Four different brackets in combination with the FRPC and NiTi wire were studied for friction of the archwire with simulated wear and surface roughness. A three-part study was conducted using an Instron universal testing machine, a scanning electron microscope, and an atomic force microscope. Variables were compared using the least significant difference (LSD) multiple comparison to determine statistical significance at the 5 per cent level.
RESULTS: There was no statistical significance difference in friction between the various groups. A statistically significant difference was found for roughness between the groups. No statistical difference was found within individual groups in either the friction or roughness study. No correlation could be determined between friction and roughness. From the LSD multiple comparisons, only the ICE-FRPC group showed statistical significance when compared with the Gemini-FRPC group. No other groups showed any significant difference. If however, a *post hoc* Bonferroni adjustment was carried out for the multiple comparisons, then the Gemini-FRPC group would no longer be statistically significant. For all NiTi wire groups, there were significant differences when compared with ICE-FRPC group. This indicates that the difference in surface roughness produced was significantly higher in ICE-FRPC when compared with the NiTi wire and other bracket combinations.
CONCLUSION: FRPC wire shows promising results in its application as an orthodontic archwire. Further research and refinement in its manufacture would be necessary to fully realize its potential as an aesthetic orthodontic archwire.

125 A DEVICE FOR MONITORING MANDIBULAR ADVANCEMENT SPLINT EFFICACY**

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AIM: This prospective clinical study of 10 subjects with obstructive sleep apnoea (OSA) analysed the success of the SleepStrip® in assessing the clinical effectiveness of the Herbst mandibular advancement splint (MAS). The SleepStrip® has been designed as a disposable sleep apnoea screening device, measuring respiration during sleep and counting the number of apnoeas and hypopnoeas.
MATERIALS AND METHOD: Overnight polysomnography with sleep nasendoscopy was used to diagnose patients with mild and moderate OSA who were suitable for treatment with a MAS. Questionnaires were used to determine baseline levels of snoring and the extent of daytime somnolence. These included the Epworth Sleepiness Scale (ESS), the SF-36 'quality of life' questionnaire, visual analogue scales for snoring and daytime sleepiness, and specific questionnaires for the patient and their partner relating to general symptoms of snoring and daytime somnolence. These latter two questionnaires were compared for discrepancies between the patient and sleep partner. A Herbst MAS was fitted. All questionnaires were

repeated to examine changes that occurred after wearing the appliance. The SleepStrip® was not used to assess the efficacy of the MAS. Two SleepStrips® were provided for each subject, one was worn at night without the MAS and one with the MAS *in situ*. The questionnaires were posted back to the investigator for analysis of the results.
RESULTS: All subjects completed the study. The results of the questionnaires showed that the MAS significantly reduced the incidence of snoring ($P = 0.007$) and improved the symptoms of daytime sleepiness ($P = 0.020$) in patients with OSA. The ESS was reduced by a median of 13.5 to 10.5 – a change of 26 per cent ($P = 0.011$). The results of the SleepStrips® showed that the MAS reduced the number of apnoeas and/or hypopnoeas experienced by patients with OSA ($P = 0.004$). All subjects had reduced SleepStrip® scores when their splint was being worn.
CONCLUSIONS: The use of the SleepStrip® was clinically effective in assessing the success of a MAS in patients with OSA.

126 MORPHOLOGICAL CHARACTERISTICS OF AS-RECEIVED AND *IN VIVO* STAINLESS STEEL ARCHWIRES

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AIMS: To characterise the surface topography of as-received rectangular orthodontic stainless (SS) archwires, and to evaluate the SS clinical bracket-archwire contacting surfaces after orthodontic treatment.
MATERIALS AND METHOD: Surface characteristics of both the as-received and *in vivo* SS archwires were examined using a scanning electron microscopy (SEM) equipped with energy dispersive X-ray analysis (EDAX). The samples were located and orientated by means of reference marks. The SS archwires were ultrasonically cleaned at a temperature of 60°C with an alcalic product (VR 6334-16, Henkel) for 15 seconds, followed by sulfamic acid for 15 seconds, rinsed with ethanol (naturalized ethanol + 5% diethyl ether) and dried with warm air.
RESULTS: The as-received wires showed an inhomogeneous surface with different surface irregularities caused by the manufacturing processes. It is not clearly known from the manufacturers' information leaflets how the alloys were processed. Grooves parallel to the long axis of the archwire resulting from the archwire drawing process were present on each sample. SEM micrographs also showed plastic deformations, scratches not parallel to the long axis due to an occasional mechanical impact, and pits due to a chemical interaction. Each sample had its own characteristic surface structure. An increase in surface defects was observed on the *in vivo* archwires, which was caused by handling during orthodontic treatment. The corrosion resistance of a SS material is mainly related to the Cr_2O_3-based passive layer on the surface. Alterations of this layer caused by the surface irregularities make the material more prone to corrosion. SEM micrographs showed crevice corrosion in the irregularities caused by manufacturing and treatment and in the bracket-archwire contacting areas.
CONCLUSIONS: The biocompatibility of an orthodontic appliance is an important determining factor in the choice of a material. Corrosion phenomena might contribute to the release of foreign substances in the oral cavity that may have biological implications, especially nickel ions, which may possibly lead to allergic reactions.

127 MEASUREMENTS ON STUDY MODELS: PLASTER VERSUS DIGITAL MODELS

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AIM: Many clinical studies are based on measurements performed on study casts. The validity of such studies can however be questioned as their precision varies considerably. The aim of this research was to evaluate whether the validity of measurements carried out on plaster models can be improved by the application of digital models.
MATERIALS AND METHOD: Two sets of impressions were taken, with an interval of 1 hour, of 12 individuals, and plaster models were produced; later the same models were converted into digital models (O3DM®). Seven distances (tooth width of one incisor and one molar, upper and lower intercanine distance upper and lower posterior arch width and length, in addition to overjet and overbite) and three angles (rotation of an incisor, a molar and a canine) were measured on all casts. The measurements on the first set of study casts and the digital models were repeated for estimation of intraexaminer variation. The measurements obtained from the plaster models were evaluated by description of the numerical values of the difference. Intra- and interexaminer variation related to measurements of plaster and digital models were evaluated by ANOVA.
RESULTS: The differences in the measurements performed on the two sets of plaster casts were statistically significant regarding arch width and length. The mean differences ranged between 0.2 and 0.5 mm. The intraexaminer method error related to the measurements of plaster casts was not significantly different from zero but the variation was up to 1.5 mm. The range of the interexaminer variation was even larger, although not significant. The error of the method related to

measurements of digital models was, on the other hand, significantly smaller, within 0.1 mm. The reduced variation related to the measurement performed on digital study casts could be ascribed to the fact that measurements can be optimised in relation to points on a given digital virtual plane and therefore a more well-defined method can be used.
CONCLUSION: The software developed for measurements on virtual models provides the orthodontists with a tool that allows them to perform measurements in a more standardized and thus more accurate way than measurements on traditional plaster models.

128 COMPARISON OF VARIOUS RETAINERS

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AIM: To compare the retention characteristics of two removable retention devices which are commonly used in orthodontic practice.
SUBJECTS AND METHOD: Forty-two non-extraction patients. Twenty (14 girls, 6 boys) had worn Hawley retainers and 22 (16 girls, 6 boys) Essix retainers for 1 year after completions of their orthodontic treatment. The patients were examined 2 years after retention for the follow-up control. Irregularity index, intercanine width, arch length and Hayce Nance measurements were assessed for both maxillary and mandibular arches from dental models, and incisor positional and vertical skeletal changes were evaluated on cephalograms. A Mann-Whitney *U* test was used to compare the changes between the two groups, and ANOVA and Bonferroni's tests to determine the mean differences between time intervals in both groups. Differences between end of treatment and follow-up measurements were considered as relapse.
RESULTS: A significant relapse was found for mandibular irregularity index and Hayce Nance measurements in both retainer groups. The amount of relapse in mandibular arch length and maxillary Hayce Nance measurements were statistically significant for the Hawley group. On the other hand maxillary irregularity index and maxillary intercanine width measurements were found to be statistically significant for the Essix group. Cephalometric variables did not show any statistically significant difference that could be considered as relapse. When the measurements between the two groups were compared, no differences were found between the initial values of any parameters. The type of retainer was an important factor in planning the retention phase of treatment.
CONCLUSIONS: Essix appliances do not appear to be less effective than Hawley retainers in maintaining orthodontic corrections, and the retention characteristics of both retainers are similar.

129 A CEPHALOMETRIC COMPARISON OF CHILDREN WITH UNILATERAL CLEFT LIP AND PALATE FROM THREE DUTCH CLEFT CENTRES

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AIM: Specific information of facial development in unilateral cleft lip and palate (UCLP) children is essential for adequate orthodontic and surgical treatment planning. In order to develop a cephalometric 'gold' standard in the Netherlands, cephalometric measurements from three cleft lip and palate (CLP) centres were evaluated and compared with children without clefts (controls).
SUBJECTS AND METHOD: Fifty-four children with CLP (41 boys, 13 girls) who had participated in a clinical trial into the effects of infant orthopaedics (Prahl *et al*., 2001), were born between 1993 and 1996, with a complete UCLP, with no other congenital anomalies and were all treated according to the same surgical protocol. Lateral cephalograms were taken at 4, 6 and 9 years of age and scanned using an Epson 1680 pro-scanner at 300 dpi. The Viewbox 3 program was used for digitization. The cephalometric measurements were statistically evaluated, tested, and compared with control data derived from the Nijmegen Growth Study.
RESULTS: No significant differences were found between the teams. Compared with data from the Nijmegen Growth Study, a tendency towards retrusion of the maxilla and mandible was seen. Lower face height was increased. Whilst these results confirm the findings of previous studies, it is however, believed that a Dutch standard is desirable.
CONCLUSION: No significant differences between the three teams were found and therefore the cephalometric data can be pooled and used as the Dutch gold standard for UCLP.

130 ARE PERIAPICAL RADIOGRAPHS RELIABLE IN DETECTING APICAL ROOT RESORPTION?

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AIM: To test if apical root resorption during orthodontic tooth movement is detectable on periapical radiographs.

MATERIALS AND METHOD: In standardized experimental orthodontic tooth movement in 16 subjects, 29 premolars were moved buccally during 8 weeks with application of a force of 1 N. Nineteen contralateral premolars, not subjected to orthodontic tooth movement, served as the controls. Standardized periapical radiographs were taken before and after the experimental period (Rx-method). These teeth were then extracted and scanned in a microcomputed tomographic scanner with a resolution of 9 μm. Two calibrated examiners assessed blindly the presence or absence of apical root resorption on the digitized radiographs, and evaluated the presence or absence of apical root resorption on the three-dimensional reconstructions of the scans. To compare the differences between the experimental and control group and the two methods (Rx versus CT-scanner) Pearson's chi-square test was performed. By taking the scanner images as the 'gold' standard, the validity of the Rx-method was assessed. The specificity and sensitivity of the Rx-method were calculated.
RESULTS: Significant differences were found between the orthodontically moved teeth and the controls. Eighty-six per cent of the orthodontically moved teeth showed apical root resorption when using the CT-scanner as a diagnostic tool compared with 5 per cent of the control teeth. When evaluating the results with the Rx-method, the presence of apical root resorption was visible radiographically in 55 per cent of the orthodontically moved teeth and in 5 per cent of the control teeth. The Rx-method showed a high specificity of 90 per cent and a relatively low sensitivity of 53 per cent, which means that only half of the cases with apical root resorption verified by the CT-scanner could be identified on periapical radiographs.
CONCLUSION: Nearly all the orthodontically moved teeth showed apical root resorption. Apical root resorption may be underestimated when evaluated on periapical radiographs.

131 EFFECTS OF THERMOCYCLING ON SHEAR BOND STRENGTH OF A SELF-ETCHING PRIMER

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AIM: To evaluate the effects of thermocycling on shear bond strength (SBS) of a self-etching primer after 2000 and 5000 thermal cycles.
MATERIALS AND METHOD: Brackets were bonded to bovine incisors with different etching protocols. In the control group [conventional method (CM)] the teeth were etched with 37 per cent phosphoric acid. In the study group, a self-etching primer (SEP; Transbond Plus; 3M Unitek) was applied as recommended by the manufacturer. The brackets were bonded with a light-cure adhesive paste (Transbond XT; 3M Unitek) and light-cured for 20 seconds in both groups. SBS was measured after immersion in water at 37°C for 24 hours or after 2000 or 5000 cycles of thermocycling between 5°C and 55°C. Data were analyzed using two-way analysis of variance and Tukey multiple comparison test. Bond failure interface was determined with the Adhesive Remnant Index (ARI). ARI values were analyzed with Kruskal-Wallis and Mann-Whitney *U* non-parametric tests.
RESULTS: In the CM group, SBS did not show any significant differences among 0, 2000 and 5000 thermal cycles. However, in the SEP group, SBS decreased with 2000 and 5000 thermal cycles, and these decreases were significantly different from no thermocycling ($P < 0.001$). A significant difference was observed between ARI scores of the CM group with 5000 thermal cycles and the SEP with no thermal cycles ($P < 0.003$). In addition, a significant difference was found between the group without thermocycling and with 5000 thermal cycles ($P < 0.003$).
CONCLUSION: Transbond Plus SEP provides clinically acceptable bond strength values when compared with the CM after thermocycling.

132 EFFECT OF PREMOLAR EXTRACTIONS ON TEMPOROMANDIBULAR JOINT DISORDERS

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AIM: To evaluate the effect of premolar extractions in orthodontic treatment on temporomandibular joint disorders (TMD).
SUBJECTS AND METHOD: Forty subjects divided into four equal groups and classified as: 1. Non-extraction; 2. Extraction of two upper first premolars; 3. Extraction of four first premolars; 4. Combined extraction group. Helkimo's scores were evaluated before, immediately after, and 1 and 2 years after treatment. The data were analyzed with ANOVA and paired *t*-tests.
RESULTS: Both immediately after treatment and at the 2 year follow-up, Helkimo scores were lower compared with pre-treatment ($P < 0.001$). No significant differences were seen between the groups for the evaluations at 1 and 2 years. No significant difference was seen between the four groups in the final appraisal of TMD.
CONCLUSION: Extraction treatment has no adverse effect on TMD. However, the upper incisors were normally inclined after treatment.

133 INFLUENCE OF ARCHWIRE ALLOY AND SECOND-ORDER ANGULATION ON FRICTIONAL FORCES

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AIM: To determine the influence of archwire alloy on static and kinetic frictional forces while varying second-order angulation.

MATERIALS AND METHOD: Static and kinetic friction generated by four types of orthodontic archwires [stainless steel (SS) Ormco; beta-titanium (ß-Ti) TMA, Ormco; nickel-titanium (NiTi, Ormco); and ion implanted ß-Ti (TMA Low Friction, Ormco)] were measured at three different second order angulations (0, 4 and 8 degrees). The archwires (0.019 × 0.025 inch) were drawn through 0.022-inch slot SS brackets (Mini-Diamond, Ormco) fixed on acrylic cylinders mounted on a specially designed and machined apparatus that allowed variation of second-order angulation. Frictional forces were measured using an Instron universal testing machine. Each of the 12 archwire/angulation combinations was tested 10 times, and each of the tests was performed with a new bracket-wire sample. Data was analysed by a 3 × 4 factorial analysis of variance (ANOVA) followed by Student Neuman Keuls comparison of means.

RESULTS: Static and kinetic friction were significantly affected ($P < 0.001$) by both second-order angulation and archwire alloy. With increasing angulation, friction increased for all archwire types. At 0 degrees angulation, SS archwires produced significantly lower static friction than the ß-Ti archwires. At 4 degrees angulation, both the ion implanted ß-Ti and NiTi archwires produced lower levels of static and kinetic friction than SS and ß-Ti archwires. At 8 degrees angulation, Ni-Ti archwires produced the lowest static and kinetic friction values.

CONCLUSIONS: (1) When second-order angulation was increased, friction increased for all archwire alloys. (2) SS wires reduced static friction only in the passive state. (3) NiTi archwires produced lower levels of friction at higher angulations. (4) Ion implantation of archwires is an effective way of reducing friction.

134 EFFECT OF DENTAL ARCH CONVEXITY AND TYPE OF ARCHWIRE ON FRICTIONAL FORCES

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AIM: Measurements of friction are often derived from models where the brackets are placed on flat models with straight wires (Chimenti *et al*., 2005). However in some areas the dental arches are not only straight but also convex. The objectives of this study were to compare the friction generated by the conventional straight and convex dental arch set-up for better simulation of the clinical situation, and to evaluate the effect of different archwires on friction.

MATERIALS AND METHOD: Two stainless steel matrices were designed simulating a straight and curved maxillary right buccal dental arch. Five maxillary incisor (11) and second premolar (15) stainless steel brackets (slot size: 0.22 inch, Victory, 3M) and a molar tube for the first molar (1.6) were aligned on the metal matrix, with equal distances of 6 mm, and clamped. Four types of orthodontic wires were tested: type 1: A.J. Wilcock Australian wire (0.016 inch, G&H Wire Company), type 2: 0.016 × 0.022 inch (3M Unitek), type 3: 0.018 × 0.022 inch (3M Unitek) and type 4: 0.019 × 0.025 inch (3M Unitek). Grey elastomeric modules (Power 'O' 110, Ormco) were used for ligation. Friction tests were performed in the wet state by artificial saliva lubrication (Saliva Orthona, Orthana, Castrup, Copenhagen, Denmark) and by pulling 5 mm lengths of the archwire. Six measurements were made for each bracket-wire combination and each test was performed with new combinations for both arch set-ups (n = 36, n = 6/per group) using a universal testing machine (crosshead speed: 20 mm/minute).

RESULTS: Statistically significant differences were observed between the straight and curved arch models ($P < 0.05$) with the latter generating more overall (1014-1653 g; 679-1270 g) and between archwires ($P = 0.00$) friction (ANOVA and Tukey test). The highest mean friction value was obtained for type 2 wire on the convex model (1653 ± 464 g), which was significantly higher ($P < 0.00$) than the type 1 (1014 ± 290 g) and type 3 (1142 ± 435 g) wire, but not significantly different ($P = 0.961$) than the type 4 wire (1503 ± 422 g). The interaction between the tested factors was not significant ($P = 0.996$).

CONCLUSIONS: The convex buccal dental arch model results in higher frictional forces. Round Australian wire (0.016 inch) created the least overall friction, while among square archwires the type 3 wire revealed the least frictional forces in both straight and convex models.

135 IS LATE MANDIBULAR ANTERIOR GROWTH ROTATION A RISK FACTOR FOR INCISOR RELAPSE?

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AIM: To test the hypotheses that pronounced post-adolescent anterior mandibular rotation is associated with relapse of mandibular incisor alignment and that mandibular anterior rotation is conducive to the occurrence of more severe relapse.

SUBJECTS AND METHOD: Based on the amount of mandibular anterior rotation post-treatment, two groups of orthodontically treated males were selected: one with pronounced anterior rotation (Max AR group; n = 27), defined as

a maximal decrease of sella-nasion/gonion-menton angle (SN/GoMe), and one with minimal anterior rotation (Min AR group; n = 29). Cephalograms and study models from before (T1) and after (T2) treatment and a minimum of 10 years post-retention (T3) were evaluated and SN/GoMe, Irregularity Index (II) and intercanine width (3-3) were measured.
RESULTS: The incisor II increased in both groups from T2 to T3 but independent *t*-tests failed to detect any inter-group difference ($P = 0.969$). The proportion of moderate crowding (II ≥3.5 mm and ≤5.5 mm) was three times higher in the Min AR than in Max AR group ($P = 0.03$). However, when individuals with mild (II <3.5 mm) and moderate crowding were pooled within each group, $\chi 2$ tests failed to demonstrate inter-group difference.
CONCLUSIONS: Mandibular anterior rotation does not contribute to relapse of incisor alignment in males. Pronounced anterior rotation is not conducive to the occurrence of more severe relapse in males.

136 FINITE ELEMENT AND PHOTOELASTIC MODEL EVALUATION OF THE TENSIONS GENERATED AROUND MINISCREWS

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AIM: The use of miniscrews in order to obtain skeletal anchorage has become a common practice in orthodontic treatment. However, little is currently known about the biomechanical characteristics of this system. In this study, the tensions that develop around a miniscrew inserted into the jaw and subjected to different loads were analysed.
MATERIALS AND METHOD: Using the photoelastic system and finite element method (FEM), the biomechanical properties of the tensions generated at the interface between the screws and bone tissue were analysed. In the first system, miniscrews, of various lengths and diameters, once inserted into a resin plate, were subjected to loads of force between 50 and 300 g, and the effects produced by the different loads were analysed. Observation of the photoelastic tensions on the miniscrews was carried out by polariscope using polarised white, monochromatic light. With the FEM, three different situations of osseous integration with a miniscrew of 11 mm in length and 1.3 mm in diameter were simulated in order to highlight the Von Mises tensions generated both inside the miniscrew and in the bone-miniscrew contact area.
RESULTS: From the photoelastic analyses of these plate-screw systems, an identical distribution of tension around the screw, both after modification of the length of the screw and after modification of the subjected loads, was found. FEM simulations demonstrated that even a load of 200 g applied to the miniscrew, without osteointegration, resulted in a Von Mises stress of 96 MPa, which is very close to the value of 122 MPa, the limit at which bone fractures. In the other simulations the stress values diminished progressively with partial or total osteointegration.
CONCLUSIONS: For the variations in load (range 50-300 g), the tensions generated around the miniscrew inserted into the resin plate were similar, whatever length of screw was considered. From the FEM simulation it was shown that osteointegration considerably reduces the stresses around the screw. Furthermore all forces generated in function of the load at the interface bone-screw were concentrated almost exclusively in the cortical thickness. Therefore from this preliminary study, the evolution of miniscrews should progress towards shorter, wider and partially osteointegratable screws.

137 SELF-ORGANISING HUMAN MASSETER MUSCLE-DERIVED CONSTRUCTS

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AIM: To investigate the use of human masseter muscle-derived cells to engineer self-organising three-dimensional muscle constructs.
MATERIALS AND METHOD: Human masseter muscle-derived and rat limb muscle-derived cells were isolated, expanded and seeded on a fibrin gel suspended on a non-stick layer of Sylgard and attached at either end to silk sutures (12 mm apart) analogous to tendon attachments. Low serum growth medium, containing insulin-like growth factor, was added to the wells containing the seeded fibrin gels, which were placed in an incubator at 37°C in a humidified atmosphere of 5 per cent carbon dioxide. Phase contrast microscopy was used to monitor cellular changes over time.
RESULTS: The rat limb muscle-derived cells attached to the fibrin gel, aligned between the sutures, and caused the gels to roll at the margins; by day 7 the gels had rolled up into an organ-like structure attached at either end to sutures. Human masseter muscle-derived cells also attached to the fibrin gel, aligned and caused the gel to roll at the margins, but less rapidly. Holes appeared in the gels at day 4 and the gels detached from the sutures by day 7, resulting in loss of cellular alignment. This may be due to human cells dividing less rapidly than the rat limb muscle-derived cell cultures. Nevertheless, crossing the holes that appeared in the fibrin gel, large myotube-like structures were observed in an attempt to maintain structural integrity.

CONCLUSIONS: Rat limb muscle-derived cells formed self-organising organoids over a 7 day period, whereas human masseter muscle-derived cells did not maintain structural integrity and broke down by day 7.

138 INVESTIGATION OF BACTERAEMIA AFTER RAPID MAXILLARY EXPANSION

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AIM: To investigate the transient bacteraemia following the removal of a modified bonded rapid maxillary expansion (RME) appliance.
SUBJECTS AND METHOD: Twenty-five subjects (15 females, 10 males) aged between 12 and 16.6 years (mean 14.4 years). All subjects underwent RME with the same appliance design at the onset of orthodontic treatment. Two 10 ml blood samples were taken, the first as a baseline and the second 3 minutes after appliance removal. All blood samples were incubated in an automated blood culture system and bacteria were identified using conventional biochemical methods and bioMerieux API kits.
RESULTS: There was no sign of microbial growth in any blood sample taken before removal of the RME appliance. Overt soft tissue bleeding was observed in 11 patients during appliance removal and, among these, eight showed bacteraemia after appliance removal. The bacteria isolated were *S. sanguis*, *S. mutans*, *S. oralis*, *S. hominis*, *S. aureus*, *Kocuria rosea* and *M. luteus*. The data were analyzed using Fisher's exact test. No statistically significant relationship was found between overt bleeding and the incidence of bacteraemia ($P = 0.054 > 0.05$).
CONCLUSION: It is suggested that orthodontists should consider the possibility of bacterial endocarditis in at risk patients when using a splint type tooth and tissue-borne RME appliance or a similar type of fixed acrylic appliance.

139 EVALUATION OF PHYSICAL PROPERTIES OF SURFACE TREATED NiTi ARCHWIRES

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AIM: The physical behaviour of a new electrochemically treated orthodontic NiTi archwire was investigated and compared with other untreated archwires. Further investigations will reveal the surface conditions with an electron microscope, a morphometric analysis and a surface profilometer. NiTi wires are machined by a grinding process, leaving more or less rough traces. In order to improve the surface, electrochemical polishing has been developed which indicates increases of the surface condition and the properties. The influence of surface treatments on the properties of the wires was investigated.
MATERIALS AND METHOD: Twenty untreated NiTi alloy wires (0.016 × 0.022 inch Opto-Therm: ODS, Kisdorf, Germany), 20 untreated Sentalloy wires (0.016 × 0.022 inch Bio Force Sentalloy: GAC, Bohemia, New York, USA), and 20 electrochemically treated NiTi wires (0.016 × 0.022 inch: ODS) were used for comparison. The force losses due to friction were measured using the Orthodontic Measurement and Simulation System. The wires were characterized by obtaining the following measurements at an ambient temperature of 37°C: a three-point bending test with the supporting points spaced 10 mm apart (3PKT), the determination of the torque/bending angle curves using a pure bending test (FLEX), a levelling test simulating an extrusion (NIVEL) and a friction test in order to determine the loss in orthodontic force due to friction between archwire, bracket (0.018 inch slot Discovery: Dentaurum, Ispringen, Germany) and steel ligature (FRIC).
RESULTS: All treated archwires had reduced friction compared with an untreated reference wire from the same manufacturer, and Sentalloy wires. Measured frictional losses of the untreated wires ranged from 26-48 per cent, with the electrochemical treatment reducing the frictional losses to around 20 per cent in some cases. The bending tests did not show changes in material properties and levelling strength.
CONCLUSIONS: An unequivocal correlation between surface roughness and frictional forces of the wires could be verified.

140 INTRAORAL BIOFILM FORMATION ON DIFFERENT ORTHODONTIC BONDING MATERIALS

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AIM: The biocompatibility of different orthodontic bonding materials was tested with a new clinical *in vitro* study design. Biofilm formation was evaluated by measuring biofilm height and vitality in different biofilm layers.
MATERIALS AND METHOD: To investigate plaque formation on the surface of different orthodontic bonding materials, one probe of each: a) resin-modified glass ionomer cement (Fuji Ortho LC™), b) three different light cure resins (Blugloo™, Heliosit®, Transbond™ XT), and c) a chemically-cured composite (Concise™) were inserted in a mandibular acrylic splint. As a negative control, the cold cure acrylic (Steady Resin S), which was used for fixation of the catching hooks to fix the

probes on the mandibular acrylic splints, was also inserted. Ten volunteers were instructed to wear the splints for 5 days (120 hours) for nearly 24 hours per day. The biofilm probes were removed washed with physiological saline and vitally stained with etidium bromide and fluorescein dictate. Biofilm height, total vitality of the biofilm probe, and vitality course were evaluated by confocal laser scanning microscopy.
RESULTS: The surface of all adherent biofilms on the probes was uneven. The biofilm height ranged from 24 to 118 µm. There were no statistically significant differences between the mean values of biofilm height for the six tested materials. Biofilm vitality values ranged from the minimal rate 23 ± 12.4 per cent on Steady Resin S to the highest rate of 40.1 ± 22.2 per cent on Heliosit®. There was no statistically significant difference between the tested materials for the mean values of biofilm vitality. For all materials tested the vitality decreased from the upper to the lower levels ($P < 0.001$). No statistically significant difference was found between the tested materials when compared with the vitality rate of the different parts of the biofilm. Bacterial accumulation was independent of the bonding material used. This can be explained by early pellicle formation that probably masks surface irregularities and reduces the transport of soluble substances out of the slabs. A high standard deviation between the different volunteers was noted, which reflects the diversity of the human plaque flora.
CONCLUSIONS: Intraoral biofilm formation is material independent, with no difference between the tested materials.

141 CONDYLAR GROWTH AND MANDIBULAR POSITIONING WITH VARIOUS MODES OF BITE JUMPING

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AIM: To compare the effects of different Class II malocclusion treatments on condylar growth and positioning of the mandible.
MATERIALS AND METHOD: A series of lateral cephalograms (taken in centric occlusion and full-mouth open) obtained at the start, and after approximately 6 and 12 months of treatment from three groups of consecutively treated patients, using a headgear-activator with stepwise mandibular advancement (HGA-S), a headgear-activator with maximum advancement of the mandible (HGA-M), and a headgear-Herbst appliance with stepwise advancement (HGH-S). Six-month growth data from matched controls were used to calculate the net treatment effects. The methods used for cephalometric analysis were devised by Pancherz (1982) and Pancherz and Hägg (1985).
RESULTS: Mandibular prognathism was enhanced after stepwise advancement but not maximum jumping, and only during the initial phase of therapy. The effects were significantly larger for the fixed functional appliance (HGH-S) than the removable appliance (HGA-S). Lower face height was increased by HGA-S, unchanged by HGA-M, and restrained by HGH-S. The low construction bite of the HGH-S meant that the extent of bone apposition on the posterior and superior parts of the condyle was similar, whereas the high construction bite of HGA-S and HGA-M meant that the effect on the superior part was larger, but only significantly so after stepwise advancement.
CONCLUSION: The mode of bite jumping, vertical opening, and whether the functional appliance is fixed or removable affects the amount and pattern of condylar growth, and positioning of the mandible.

142 SKELETALLY-ANCHORED RAPID MAXILLARY EXPANSION – A THREE-DIMENSIONAL EVALUATION

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AIM: To carry out three-dimensional analysis of the teeth, alveolar and skeletal structures during bone-borne, surgically-assisted rapid maxillary expansion (RME) with the Dresden Distractor (DD). The aim was to determine whether body or skeletal movement of the segments would be possible while reducing the dento-alveolar side-effects associated with tooth-borne RME.
MATERIALS AND METHOD: Standardized axial computer tomography was performed on 15 patients, average age 25.3 years, prior to and 6 months after RME with the DD. Reference levels and the triple-O-ELSA were defined bilaterally with reference to the following anatomic points: the foramina spinosa, porus acustici externi and the front rim of the foramen magnum. The amount of movement that occurred before and after RME with the DD against ELSA was measured.
RESULTS: Screw-activation of 6.0 mm resulted in transverse expansion of 5.6 mm in the alveolar process in the premolar region and 4.9 mm in the molar region, with 8-9 degrees of buccal tipping of the alveolar processes. The dental tipping observed was 4-8 degrees less than that demonstrated in the alveolar processes. The teeth were raised due to the torque effect

of the multibracket appliance, and expansion forces were delivered directly to the bone. Skeletal change was evident, as only slight buccal tipping of the premolars (3.1-4.6°) and molars (1.1-2.6°) occurred with an increase in width of 6.1 and 4.9 mm, respectively. Eighty-five and 91 per cent of the total expansion measured at the crowns in the molar and premolar regions, respectively, was achieved skeletally; corresponding values for surgically-assisted, tooth-borne RME were skeletally less efficient. Autorotation of the mandible in the ventral and cranial directions was possible due to considerably less dental tipping resulting from RME with the DD in comparison with the tooth-borne RME. This fact demonstrated that the DD is also well suited for patients with vertical growth pattern.
CONCLUSIONS: Bone-borne DD is an effective therapeutic method without the negative side-effects associated with tooth-borne RME reported in literature, such as root resorption, bone dehiscence, bite opening and excessive buccal tipping of the teeth.

143 EXPRESSION OF A CARABELLI CUSP AND ITS ASSOCIATION WITH PERMANENT TOOTH SIZE

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AIM: To examine the expression of Carabelli trait in Afro-American and Caucasoid children, and the association between the positive cusp of Carabelli and permanent tooth crown size.
SUBJECTS AND METHOD: Two thousand one hundred and thirty six Caucasoid (40%) and Afro-American (60%) children, who participated in the cross-sectional study of the Collaborative Perinatal Project (USA) in the 1960's and 1970's and the Genetic Odontometric Study of Prenatal and Neonatal Growth project in the USA (started 1972). Dental examinations were carried out at the age of 6-12 years. Tooth crown size measurements were performed on the dental casts with an electronic measuring device and read by two experienced observers according to precise definitions generally quoted in the anthropological and genetic literature. The cusp of Carabelli was observed from the dental casts and the classification by Dahlberg (1955) was used as criterion. The study group was also divided by gender. The chi square test was used for statistical analysis.
RESULTS: The prevalence of a positive cusp of Carabelli was significantly larger in Caucasoids compared with Afro-Americans (26/21% $P < 0.01$) and larger in boys compared with girls (25/21%, $P < 0.01$). Significantly larger permanent upper and lower first molars ($P < 0.001$) and permanent upper and lower first and second incisors ($P < 0.001$) were found in children with a positive Carabelli cusp in the second primary molar and/or in the first permanent molar. The crown size of the permanent canine and first and second premolars were also increased. The results were significant for all study groups, even according to gender and race.
CONCLUSIONS: The expression of the positive cusp of Carabelli in the primary or permanent dentition seems to be associated with generally increased permanent tooth crown dimensions. The results are useful in orthodontic treatment planning, space analysis and prediction of crowding.

144 INFLUENCE OF DIFFERENT BLEACHING REGIMENS ON THE SHEAR BOND STRENGTH OF BRACKETS

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AIM: The increasing popularity of dental bleaching and the availability of (non-dentist-supervised) home bleaching materials raise the question as to whether a bleaching procedure prior to bonding affects the bond strength of the brackets. Some studies have dealt with this topic but so far none of them have examined the influence of different bleaching regimens on bracket adhesion. The aim of this *in vitro* study was to investigate the influence of three different bleaching methods on three different bracket adhesives, and to determine whether a prolonged washout period was beneficial.
MATERIALS AND METHOD: The crowns of 315 bovine lower incisors were removed, embedded in polyurethane resin, with the labial surfaces uppermost, and randomly divided into 21 groups. Three different bleaching protocols were performed: 3.6 per cent carbamide peroxide (Odol-med3 Intensive White) twice daily for 14 days (groups 4-9), 15.0 per cent carbamide peroxide (Illuminé home, Dentsply) 8 hours daily for 10 days (groups 10-15) and 35.0 per cent H_2O_2 (Hi-Lite, Shofu) twice for 20 minutes (groups 16-21). Groups 1-3 served as controls and did not undergo a bleaching procedure. Following the bleaching procedure, the specimens underwent two different washout periods in artificial saliva for 12 and 72 hours, respectively. The brackets were then fixed with three different adhesives: (1) 37 per cent phosphoric acid and Transbond XT Primer and Adhesive (3M Unitek), (2) light curing glass ionomer cement (GIC; Fuji Ortho LC), (3) Transbond Plus (self etching primer) and Transbond Adhesive (3M Unitek). Light curing was carried out with a plasma lamp (American Dental Technologies) from the mesial, distal and cervical for 5 seconds each. After 24 hours storage in artificial

saliva the brackets were debonded at a 90 degree angle and at feed rate of 1 mm/minute. Maximum values (Newtons) were recorded and later converted into MPa.
RESULTS: Shear bond values in the GIC group showed the lowest results. Transbond Plus provided the highest values. Bleaching did not affect the values for the GIC and the conventional etching method. The groups in which brackets were bonded with Transbond Plus showed lower shear bond strength values for the 15 per cent carbamide peroxide and 35 per cent hydroxyperoxide bleached specimens. Prolonged washout periods were not beneficial.
CONCLUSION: Highly concentrated bleaching materials can affect the shear bond strength of self-conditioning primers.

145 ASYMMETRY OF OCCLUSION, TOOTH WEAR AND ERUPTION IN FUNCTIONAL LATERALITIES

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AIM: To summarize the findings on asymmetries of sagittal (unilateral Angle II) and transverse (unilateral crossbite) malocclusions, permanent tooth eruption and wear, in primary teeth among two types of functionally lateralized (hand, foot, eye) individuals, true-right sided children (TRS) and those who were totally or mixed non-right sided (NRS).
SUBJECTS AND METHOD: The subjects were 2149 children of the Genetic Odontometric Study of the Collaborative Perinatal Project, carried out in the 1960s in the USA by the National Institute of Neurological Disorders and Stroke in a cross-sectional manner at ages from 6 to 12 years (40% white and 60% black children). Dental variables were observed from dental casts. The laterality examination was made at 4 years.
RESULTS AND DISCUSSION: Symmetric occlusion in both dimensions, sagittal and transversal, was more common among TRS compared with NRS-children. Right side Angle II/left side Angle I occlusion occurred significantly more often in NRS compared with TRS, and a crossbite on the right side was significantly less frequent in TRS-children. For the upper permanent first molars, the proportion of symmetric tooth eruption was more common in NRS compared with TRS, and eruptions of lower first molars were significantly advanced on the left in TRS compared with NRS. For most dental variables the boys were more asymmetric than girls, and TRS white boys had significantly more right sided wear in the primary dentition compared with NRS. In black children those differences were not statistically significant. Growth directions are modified by the sidedness of oral habits and growth stimulating effect of lateralized function of the tongue and other muscles. These are apparently influenced by duration and intensity of the 'right shift' period, an inherited trait or drift of development of the central nervous system in first post-natal years.
CONCLUSIONS: Good symmetric occlusion and normal asymmetric skull bones may appear simultaneously under favourable circumstances after unilateral compensatory growth and lateralized masticatory function, under the influence of a hard diet. Asymmetric malocclusions may be the consequence if growth stimulating function is poor or unbalanced, predominantly wrong sided.

146 ASSESSMENT OF SYSTEMIC ALLOY COMPONENTS FOLLOWING ORTHODONTIC TREATMENT

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AIM: To assess, *in vitro,* ionic concentrations of specific alloys in urine after bonding fixed multibracket appliances. Two bracket types and two archwires were compared to determine possible correlations between alloy type and ionic concentrations.
SUBJECTS AND METHOD: Forty patients requiring orthodontic treatment between 12 and 35 years of age (mean 14.55 years). Inclusion criteria were absence of any type of metal filling/restoration. The patients were randomly assigned to one of four groups as follows: group A, nickel-containing brackets (Victory Series, 3M Unitek, Neuss, Germany) and archwires with a high nickel content (Sentalloy, GAC, Gräfelfing, Germany); group B, nickel-containing brackets (3M Unitek) and archwires with a low nickel content (Dentaflex, Dentaurum, Ispringen, Germany); group C, brackets with a low nickel content (Sprint, Forestadent, Pforzheim, Germany) and nickel-containing archwires (GAC); and group D: brackets (Forestadent) and archwires (Dentaurum) with low nickel content. Three urine samples were taken, prior to bonding and two and eight weeks after bonding. Ion release was assessed by inductively coupled plasma-atomic emission spectrometry (ICP-MS).
RESULTS: Neither the time *in situ* nor the material combination (bracket type/archwire) had a significant effect on the majority of elements. Antimony showed significant interaction between group and repeated measurements. Lead and molybdenum revealed significant differences between the four groups independent of time. The trend over time for group A differed completely from the other three groups.
CONCLUSIONS: There is a possible effect on the type of material combinations used. Comparison between the two bracket types and two archwires tested showed an increase in specific ion concentrations. Before final conclusions can be drawn,

favouring a specific alloy composition, a larger multicentre study is required. The results of this study, as well as a number of other investigations, underline the applicability and sensitivity of the selected ICP-MS technique for quantitative analysis of urine samples. One effect that needs to be considered in future investigations is the patient's diet.

147 EFFICACY OF LIGHT EMITTING DIODE CURING VERSUS HALOGEN CURING FOR BRACKET BONDING

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AIM: To determine the suitability of new generation light emitting diode (LED) curing units. Bracket shear bond strength (SBS) was evaluated using the LED light curing units, LEDemetron, Bluephase, Bluphase 16i (7 and 13 mm tip), Freelight II, SmartLite, Ortholux LED and Translux Power Blue, and compared with the 'gold 'standard halogen lamp, Astralis 10 (2 and 8 mm tip).
MATERIALS AND METHOD: All preparation procedures for SBS measurement were conducted according to the draft version of DIN 13990-2. Unerupted human third molars were embedded in Technovit 4002. Upper left incisor Ultratrimm brackets were bonded using Transbond XT etchant, primer and composite on flat, pumiced enamel surfaces and light cured. A thin composite layer was ensured and excess material was removed. Transbond XT was light cured 20 seconds each from incisal and gingival using one of the devices being investigated. The light probe was positioned 45 degrees and 5 mm from the bracket. The specimens were stored in distilled water for 24 hours before measuring SBS. The depth of cure was checked for each curing unit according to ISO 4049. Wilcoxon's test was used for statistical analysis.
RESULTS: SBS (in MPa) showed the following means (±SD): Ortholux LED 17.0 ± 4.2, Freelight II 16.6 ± 2.7, Bluephase 16i 13 mm 16.3 ± 3.6, Bluephase 16i 7 mm 16.1 ± 3.3, LEDemetron 15.9 ± 2.5, Translux Power Blue 15.9 ± 3.1, SmartLite 15.2 ± 3.0, Bluephase 15.1 ± 4.3. For the reference unit, Astralis 10, the means for the 8 and 2 mm light guide were 14.3 ± 4.6 and 13.0 ± 3.1, respectively. Depth of cure resulted in following data: LEDemetron 5.79 mm, Bluephase 16i 7 mm 5.57 mm, Bluephase 5.38 mm, Freelight II 5.25 mm, SmartLite 5.12 mm, Ortholux LED 5.03 mm, Bluephase 16i 13 mm 5.02 mm, Translux Power Blue 4.90 mm. Astralis 10, with an 8 mm light guide resulted in a 5.14 mm depth of cure. Ortholux LED achieved the highest SBS, followed by Freelight II and Bluephase 16i. All LED curing units create SBS above the conventional halogen device. Neither the range within the LED units nor in comparison with the halogen lamp was statistically significant. The depth of cure using an A2 shaded universal composite also did not result in a significant difference for inter-LED comparison nor in comparison with the halogen lamp.
CONCLUSION: All evaluated LED curing devices were able to reach SBS data similar to those, obtained from polymerization by an established halogen unit. The depth of cure for all units was equal to the halogen gold standard.

148 EFFECT OF LIGHT TIP-TUBE DISTANCES ON SHEAR BOND STRENGTH OF MOLAR TUBES

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AIM: Light-emitting diode (LED) units are claimed to decrease total light curing time due to their higher irradiance and greater depth of cure in comparison with conventional tungsten-quartz halogen units. It is recommended that the light guide should be placed as close as possible to the bracket surface, which is rarely performed when bonding second molars in clinical orthodontic practice. Distance is supposed to be the most important factor in decreased light intensity. Therefore, the aims of this study were to determine the effects of different light-tip distances and curing times on shear bond strength (SBS) and the mode of failure [Adhesive Remnant Index (ARI)] of molar tubes.
MATERIALS AND METHOD: Ninety human molars randomly divided into six equal groups. Group variables were: distance to the molar tube (0, 3 and 6 mm) and curing time (10 and 20 seconds). Second molar tubes (Accent, Ormco) were bonded with a conventional composite adhesive system (Transbond XT, 3M Unitek) and light-cured with a LED unit (Elipar Free Light 2 LED, 3M Espe, 1000mW/cm^2). SBS was measured with a universal testing machine (Z2.5, Zwick) and the mode of failure was assessed with an optical microscope (×10 magnification). Statistical evaluation was performed with a two-way ANOVA.
RESULTS: SBS (MPa) 10 seconds (mean ± SD): 0 mm distance 6.17 ± 2.15, 3 mm distance 4.94 ± 1.52, 6 mm distance 4.31 ± 1.30. SBS (MPa) 20 seconds (mean ± SD): 0 mm distance 8.47 ± 1.61, 3 mm distance 6.99 ± 2.60, 6 mm distance 5.85 ± 1.83. SBS were significantly affected by the decreased curing time and the increased distance to the molar tube. ARI scores for molar tubes bonded with a 0 mm distance and 20 seconds curing (median ARI value 2) time were significantly lower than those of the other groups (median ARI value 3). Simultaneously, decreasing curing time and increasing the distance resulted in SBS that were below the recommended level appropriate for clinical use.
CONCLUSION: Within the limitations of this *in vitro* study, the results show that in 'hard-to-reach' areas, curing time should be increased for optimal curing efficiency.

149 CONE-BEAM COMPUTED TOMOGRAPHY IN THE DIAGNOSIS OF JUVENILE IDIOPATHIC ARTHRITIS
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AIM: To implement the technique of cone-beam computed tomography (CBCT) of the temporomandibular joints (TMJs) in patients with juvenile idiopathic arthritis (JIA), to correlate the two-dimensional (2D) and three-dimensional (3D) CBCT data with the severity, duration and subtype of JIA, and to compare the 3D CBCT data with the 2D CBCT data and the 2D and 3D CBCT data with the panoramic radiographic data.
SUBJECTS AND METHOD: Thirty-four consecutive JIA patients (22 females, 12 males, mean age 10.8 years; range 4-19.25 years) from the Clinic of Paediatric Rheumatology were invited for clinical and radiographic TMJ examinations. A dental pantomogram (DPT) and CBCTs with the 3D Accuitomo® (Morita Co Ltd, Kyoto, Japan) of the left and right TMJs were taken. Custom-made software was used to reconstruct the condyles in three-dimensions. Previously tested scoring systems were used by two trained observers to determine condylar deformation. The severity, duration and subtype of the disease were taken from the patients' medical files.
RESULTS: Kappa statistics demonstrated good inter- and intraobserver agreement after training. Cumulative logistic analysis showed a statistically significant relationship between the subtype of JIA and the deformation score for the condyles. Fisher's exact test showed that in enthesitis-related arthritis a lower condylar deformation score was present. Kappa showed a lack of agreement between the 3D and 2D scores. A linear association between the CBCT and DPT was found for the 2D score of the right condyle for both observers. No linear association was found between the 3D and DPT.
CONCLUSIONS: Low agreement was found between the three different scoring methods for condylar deformation in JIA subjects. A statistically significant correlation was found between the 3D CBCT deformation score and JIA subtype. Implementation of the CBCT does not simplify the diagnosis of TMJ deformation in JIA patients.

150 APOPTOSIS IN HUMAN GINGIVAL FIBROBLASTS EXPOSED TO A PLASMA ARC CURING UNIT
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AIM: To determine the effects of the plasma arc photocuring unit, Fliopo (Lobel France Co. Ltd), on cell proliferation and cytotoxicity of human gingival fibroblasts *in vitro*.
MATERIALS AND METHOD: Human gingival fibroblasts grown in 96-multiwell culture plates were exposed to the blue light generated by the photocuring unit with clinically relevant intensity and distance for various times ranging from 5 to 120 seconds. After exposure, the cells were examined for signs of proliferation, cytotoxicity, and apoptosis.
RESULTS: Exposure of human gingival fibroblasts to the blue light caused a significant decrease in DNA synthesis and MTT-reducing activity in a time-dependent manner, such that more than 30 seconds of exposure exerted a toxic effect on the cells. The photocuring unit-induced cytotoxicity of the cells resulted from apoptosis, as shown by the migration of many cell populations to the sub-G0/G1 phase in the cell cycle progression and the appearance of a clear DNA ladder. PARP cleavage, but not a cell cycle arrest, was shown to be closely related to the Flipo-induced apoptosis in the cells.
CONCLUSIONS: The findings suggest that a longer curing time than recommended, can exert biological stress on the oral tissues, which may disrupt the physiological function or healing process of the oral tissues.

151 EFFECT OF SEPTUMOTOMY AFTER SECOND MOLAR EXTRACTION ON MOLAR DISTALIZATION
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AIM: To evaluate the effects of second molar extraction and interradicular septum removal on molar distalization, using an intraoral distalization mechanism emitting interrupted force.
SUBJECTS AND METHOD: Twelve Class II division 2 adolescents (6 females, 6 males, mean age 15.17 years). The dental effects of the distalization were analyzed on lateral cephalograms by means of acrylic caps with indicator wires at three stages: pre-treatment, post-distalization, and 2 months after the completion of distalization. Maxillary first premolar and first molar rotations and intermolar distance changes were evaluated from models taken at the same time periods. The upper second molars were extracted in all subjects, followed by interradicular septum removal. Vertical and horizontal cuts were then performed on the mesial socket wall. Distalization commenced the next day with bilaterally positioned compact rapid palatal expansion screws, which were activated once in two days. The mean time for the distalization was 3.25 months, and the results were stabilized with a conventional Nance appliance.

RESULTS: The maxillary first molars distalized 3.21 mm with 7.7 degrees of tipping and 4.2 degrees of mesial rotation. The anchorage loss for the premolars was 3.41 mm and for the incisors 4.41 mm, however, it was reduced to 0.34 and 2.16 mm, respectively, during the 2-month post-distalization period. The intermolar distance increased 4.42 mm during distalization, and remained stable thereafter, due to the presence of the Nance appliance.
CONCLUSION: Although not significantly reducing anchorage loss, extraction of second molars and removal of the interradicular septum, is efficient in distalization cases to obtain bodily molar movement and minimize treatment time.

152 INVOLVEMENT OF THE SIGNAL PATHWAY IN OSTEOCLAST DIFFERENTIATION INDUCED BY TNF-ALPHA**

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AIM: Multiple pathways exist in the regulatory mechanism of osteoclast differentiation, and pre-osteoclasts differentiate into mature multinucleated osteoclasts through several differentiation steps. It is important in the field of orthodontics to elucidate the intracellular signal transduction pathways in osteoclast differentiation. In this study the role of MAP kinases (ERK, p38) in RANKL or TNF-α induced differentiation of mouse macrophage-like RAW264 cells into osteoclasts were investigated.
MATERIALS AND METHOD: RAW264 cells at 5000 cells/well were incubated in 96 well plates overnight. The cells were treated with RANKL or TNF-α in the presence or absence of PD98059, U-0126 (MEK inhibitors) or SB203580 (a p38 inhibitor) for 4 days, and tartrate resistant acid phosphatase (TRAP) staining and the TRAP quantitative assay (by OD measurement) were performed. Furthermore, the cells at 2.5×10^6 cells/well were incubated in 24 well plates as described above, and Western blot analysis was performed for quantification of phosphorylated ERK or p38.
RESULT: When the cells were treated with SB203580, RANKL-induced differentiation into TRAP-positive osteoclasts was suppressed in a dose-dependent manner. On the contrary, PD98059 or U-0126 dose-dependently augmented RANKL-induced osteoclast differentiation. Similar results were obtained by TRAP quantitative assay. Similar to RANKL, TNF-α induced osteoclast differentiation was suppressed by SB203580 and augmented by PD98059 or U-0126. Phosphorylation of ERK or p38 was induced by treatment with RANKL or TNF-α. SB203580 decreased p38 phosphorylation but increased ERK phosphorylation. PD98059 decreased ERK phosphorylation and slightly decreased p38 phosphorylation. U-0126 decreased ERK phosphorylation but increased p38 phosphorylation.
CONCLUSION: Activation of p38 and inhibition of ERK may play an important role in osteoclast differentiation induced by RANKL as well as TNF-α.

153 CHANGES IN PHARYNGEAL AIRWAY AND ADENOIDS AFTER MANDIBULAR SETBACK SURGERY**

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AIM: To evaluate the changes in pharyngeal airway space and adenoid tissue associated with surgical mandibular setback with a bilateral sagittal split osteotomy (BSSO).
SUBJECTS AND METHOD: Twenty-five patients (8 males, 17 females, mean age 25 ± 4 years) all diagnosed with skeletal mandibular prognathism who had undergone orthodontic multibracket treatment and then mandibular setback surgery by BSSO. The width and the height of the pharyngeal airway and the width of the adenoid tissue were measured. Lateral cephalograms, dental pantomograms and photographs were taken pre-surgically and approximately 1 year post-surgically. The cephalograms were compared using a paired *t*- and signed tests.
RESULTS: The mean reduction in the width of the pharyngeal airway space (mps) was 3.8 ± 6.7 mm ($P \leq 0.001$). The height of the pharyngeal airway space (pns_eb) was increased 3.1 ± 4.4 mm ($P \leq 0.03$). The dimensions of the adenoid tissue (at_atp) did not show any significant changes ($P \leq 0.9$).
CONCLUSION: Mandibular setback surgery causes a decrease in pharyngeal airway width. Despite the pharyngeal narrowing there was no evidence of post-operative difficulty in breathing in any of these patients. Nevertheless, in patients with risk factors such as being overweight, having a short neck or large tongue, a mandibular setback procedure should be considered more often to relieve breathing difficulties.

154 JASPER JUMPER AND ACTIVATOR+HEADGEAR: A COMPARATIVE CEPHALOMETRIC STUDY

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AIM: To evaluate and compare the skeletal and dentoalveolar effects of a Jasper Jumper (JJ) and activator-headgear (activator+hg) combinations in the treatment of skeletal Class II malocclusions.

SUBJECTS AND METHOD: Thirty-seven Class II patients; 20 (mean age: 12.40 years) were treated with a JJ and 17 (mean age: 10.9 years) with an activator+hg. The mean treatment times were 5 and 11 months, respectively. The control group consisted of 20 Class II patients (mean age: 10.44 years) and the mean observation period was 10 months. Skeletal and dentoalveolar changes were evaluated by means of 15 linear and 18 angular measurements on standardized lateral cephalograms taken at the beginning and end of appliance wear.
RESULTS: Both appliances significantly affected maxillary and mandibular sagittal growth. The increase in the Co-A distance was significantly less in both treatment groups ($P \leq 0.05$). SNB increased and ANB decreased in both treatment groups. These changes were more pronounced in the activator+hg than in the JJ group ($P \leq 0.01$, $P \leq 0.001$). CoGn distance increased markedly in all three groups ($P \leq 0.001$) but no significant difference was observed between the treatment modalities or growth changes. The vertical dimensions did not change in any of the groups. In both treatment groups, molar relationship and overjet significantly ($P \leq 0.001$) improved. The most remarkable difference between two appliances was observed in their effect on the mandibular incisors. In the JJ group, the mandibular incisors protruded significantly ($P \leq 0.001$), while the change in the mandibular incisor position in the activator+hg group did not differ from the control.
CONCLUSION: Both JJ and activator+hg were efficient in Class II treatment. In both treatment groups, the increase in Co-A distance was 'held back'. Other contributors to Class II correction were mandibular advancement in the activator+hg group and mandibular incisor protrusion in the JJ group.

155 ORTHODONTIC ADHESIVES INDUCE HUMAN GINGIVAL FIBROBLAST INFLAMMATION

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AIM: Orthodontic resin adhesives have been shown to leak out with its residual components. There is little information on gingival tissue reaction after contact with these materials. The aim of this investigation was to evaluate the inflammation behaviour of the resin base *in vitro* and resin modified glass ionomer base adhesives after contact with primary human gingival fibroblasts.
MATERIALS AND METHOD: Resin base and resin hybrid glass ionomer base adhesives were applied to human gingival fibroblast to evaluate the survival rate using MTT assay, to detect the level of COX-2 mRNA by RT-PCR technique and COX-2 protein expression using Western blot analysis. The results were analyzed using one-way ANOVA. Differences were analyzed using the Student-Newman-Keul test. A value of $P < 0.05$ was considered statistically significant.
RESULTS: The paste and primer of the resin base adhesive and the liquid of the glass ionomer adhesive showed decreasing survival rates after 24 hours of treatment ($P < 0.05$). All orthodontic adhesives induced COX-2 protein expression in human gingival fibroblasts. The exposure of quiescent human gingival fibroblasts to adhesives resulted in the induction of COX-2 mRNA expression. The investigations of the time-dependent COX-2 mRNA expression in adhesive-treated human gingival fibroblasts revealed different patterns.
CONCLUSIONS: For orthodontic patients with gingival inflammation, except for those with oral hygiene problems, the activation of COX-2 expression by orthodontic adhesive may be one of the potential mechanisms.

156 FORCE DISSIPATION IN THE CRANIOFACIAL COMPLEX USING ORTHODONTIC APPLIANCES

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AIM: To investigate and quantify the dissipation of forces in the craniofacial complex using a variety of orthopaedic appliances.
MATERIALS AND METHODS: Stress-strain gauges (Intertechnology, Don Mills, Ontario, Canada) were attached with MBond adhesive (Intertechnology) to human adult cadaver skulls adjacent to the following suture sites: palatal, intermaxillary, zygomaticomaxillary and zygomaticotemporal. The gauges were attached to a P3 strain measuring device (Intertechnology) and forces exerted on the craniofacial complex sites were measured in units of μstrain when subject to orthopaedic forces using rapid palatal expansion (RPE), high-pull headgear (HPHG), cervical headgear (CHG), and chin cup (CC) appliances.
RESULTS: For RPE, both the palatal (560 μstrain) and intermaxillary (827 μstrain) sensors recorded the highest μstrain value ($P < 0.05$). Although much lower in magnitude ($P > 0.05$), the palatal sensor also registered μstrain values for HPHG (120 μstrain), CHG (70 μstrain) and CC (150 μstrain). Values at the intermaxillary suture were even lower ($P < 0.05$) for the HPHG (40 μstrain) and CC (39 μstrain), but similar to the palatal sensor values for the CHG (80 μstrain) ($P > 0.05$). At the zygomaticomaxillary suture even lower values, in the range of 0 to 20 μstrain, were generated ($P < 0.05$). The sensor registering the least amount of activity was located at the base of the temporomandibular joint, where values were deemed to be negligible, except when using the CC, when the values registered 120 μstrain. The further away the sensor was to the

point of force generation, the lower the recorded μstrain value. This could be due to the absorption of forces by the hard and soft tissues in the craniofacial complex during the force dissipation process.
CONCLUSIONS: Although large force levels were registered for RPE at certain anatomical sites, all the other orthopaedic appliances showed much smaller force values. This may further support the theory that either piezoelectricity mediates orthodontically induced alveolar remodelling by orthopaedic orthodontic appliances in the craniofacial complex, or mediation may be at the cellular level via signal transduction even at minimal force dissipation magnitudes at distant sites.

157 A SCANNING ELECTRON MICROSCOPIC STUDY OF ENAMEL AFTER VARIOUS DEBONDING METHODS
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AIM: To study the site of bond failure and amount of residual resin after use of one technique of debracketing, and to evaluate and compare enamel surfaces subjected to four different techniques of residual adhesive removal and final polishing.
MATERIALS AND METHOD: Thirty-two extracted first premolar teeth from 12-18 year old subjects. In order to record the enamel surfaces before bonding, impressions were taken of the teeth with a silicone material, and poured with epoxy resin. After bonding with standard metal brackets, the teeth were stored for 48 hours before bracket removal. Debracketing was carried out by squeezing the mesial and distal wings of bracket toward each other with a ligature cutter. For cleaning-up the enamel surface, the teeth were randomly divided into four equal groups. The samples in each group were subjected to different finishing procedures: group A; slow speed fissure tungsten carbide bur; group B, slow speed round carbide bur; group C slow speed white stone bur; group D ultrasonically using a Dentsply P3 tip (a modified tip with a flat edge). In each group after removal of residual resin, pumicing was undertaken on 50 per cent of the teeth, and then photomicrographs of the teeth and epoxy resin impressions were taken in scanning electron microscope at ×50 magnification.
RESULTS: Debracketing produced separation at the bracket-adhesive interface with up to 90 per cent of the composite left on intact enamel surface. Photomicrograph evaluation showed a pattern of perikymata on intact enamel in all epoxy resin dyes, fine scratches in group A, fine to moderate scratches in group B, a large number of moderate scratches and fissures in group C, and enamel surface with intact perikymata in group D. Scanning electron photomicrographs taken after pumicing showed a considerable decrease in enamel roughness.
CONCLUSION: The ultrasonic technique demonstrated the best result, fissure tungsten carbide bur and round carbide bur produced satisfactory results, the use of white stone bur is not recommended and final polishing treatment is considered as an essential stage at the end of debonding.

158 IS THERE ANY DIFFERENCE IN SKELETAL MATURITY AMONG VARIOUS MALOCCLUSION GROUPS?
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AIM: To investigate whether skeletal maturity is different among various malocclusion groups and between boys and girls. Estimating skeletal maturity in relation to personal growth spurt is essential and must be considered in orthodontic treatment.
MATERIALS AND METHOD: Hand-wrist radiographs were taken every 6 months longitudinally of 143 subjects (Class I n =37; Class II n =46; Class III n = 60). The radiographic appearance of the ulnar sesamoid bone and capping of epiphysis at the middle phalanx of the third finger (MP3-capping) were evaluated as indicators. The age of skeletal maturation events was used as variables.
RESULTS: There was no difference in skeletal maturation among the three malocclusion groups for either boys or girls ($P > 0.05$). There was a significant difference between boys and girls ($P < 0.05$). The mean age of sesamoid bone appearance was 12.4 years in boys and 10.1 years in girls, and that of MP3 capping 13.4 years in boys and 11.0 in girls. MP3 capping occurred approximately 1 year after the appearance of the sesamoid bone in both genders.
CONCLUSION: Skeletal maturation was not different according to malocclusion classification, while skeletal maturation in girls was approximately 2.3 years earlier than in boys.

159 PLAQUE LEVEL IN PATIENTS WEARING FIXED ORTHODONTIC APPLIANCES
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AIM: Dental plaque formation around brackets is a significant problem in orthodontic patients undergoing treatment with fixed appliances leading to potential development of white spot caries and localized gingival irritation. Digital plaque

imaging analysis (DPIA) is a method for the objective measurement of plaque coverage. The aim of this study was to examine the incidence and severity of plaque formation in a population of children undergoing orthodontic treatment with fixed appliances using the DPIA system.
SUBJECTS AND METHOD: Fifty-three patients with fixed upper and lower appliances, who met all inclusion/exclusion criteria. Following a screening visit, the subjects attended the clinic on one afternoon for imaging. The participants were instructed to refrain from oral hygiene after morning brushing and from eating or drinking one hour prior to the visit. During that visit they disclosed their plaque with fluorescein and DPIA images under unltraviolet illumination were taken. The image was then masked and analyzed according to a standard procedure and the percentage of plaque of the 12 anterior upper and lower teeth was calculated.
RESULTS: Orthodontic patients showed significant level of plaque coverage on the tooth area around and close to the orthodontic appliances. Plaque level ranged from 8–85 per cent. Twenty-five per cent of the patients had over 54 per cent, while only 10 per cent of them were below 15 per cent. The average mean plaque coverage was 41.9 ± 18.1 per cent.
CONCLUSIONS: DPIA represents a convenient means for assessment of plaque coverage on the dentition of patients undergoing orthodontic therapy with fixed appliances. The results of this study agree with prior applications of imaging techniques to orthodontic populations. Plaque coverage in orthodontic patients remains extremely high – for reference, averaging 2-3 times the levels observed in high plaque forming adults participating in DPIA clinical studies. Improved hygiene and chemotherapeutic regimens and compliance facilitators remain a necessity in these patients.

160 EXTERNAL BLEACHING EFFECT ON THE COLOUR OF INACTIVE WHITE SPOT LESIONS

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AIM: To evaluate the effect of external bleaching on the colour and luminosity of inactive white spot lesions (WSL) present after fixed orthodontic appliance treatment as a means for achieving colour matching of the WSLs with the adjacent tooth surface.
SUBJECTS AND METHOD: Ten patients with inactive WSL after therapy with fixed orthodontic appliances were selected. At baseline, CIE-Lab values of maxillary incisors and canines were assessed with a colorimeter. Colour determinations were performed in the area of the initial lesions (F1) and at adjacent, sound enamel areas (F2). The anterior teeth were then bleached once with the bleaching gel, Illuminé office (30% H_2O_2, Dentsply DeTrey, Germany) for 60 minutes. After a break of 14 days, in-office bleaching was followed by a two-week home bleaching period with daily home bleaching for 1 hour with Illuminé home (15% carbamide peroxide, Dentsply DeTrey). Colour determinations were then repeated. Additionally, patients were asked to fill out a questionnaire to determine their degree of satisfaction with the treatment.
RESULTS: Lab values of both the WSL regions, F1 and F2, were significantly higher after bleaching as compared with baseline. F2 Lab values increased significantly more compared with the F1 region, indicating improved colour matching of these two areas in comparison with baseline. All patients were satisfied with the outcome of the bleaching therapy.
CONCLUSION: External bleaching is able to satisfactorily camouflage WSL visible after therapy with fixed orthodontic appliances.

161 BOND FAILURE RATE OF ORTHODONTIC BRACKETS USING TWO POLYMERIZATION SOURCES

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AIM: To compare the clinical performance of two different photopolymerization sources, namely a light emitting diode (LED) lamp and a conventional halogen lamp.
SUBJECTS AND METHOD: Thirty consecutive patients presenting various malocclusions treated by fixed orthodontic appliances, by one clinician. A total of 600 stainless steel brackets (Mini, Forestadent, Pforzheim, Germany) were directly bonded using the same composite resin (Transbond XT, 3M Unitek, Monrovia, California, USA) in combination with the appropriate adhesive primer (Transbond XT, 3M Unitek). Following the manufacturer's instructions, the duration of the polymerization was 10 seconds with the LED lamp (Ortholux LED curing light, 3M Unitek) and 20 seconds with the halogen lamp (Ortholux XT curing light, 3M Unitek). A split-mouth design was randomly used, alternated from patient to patient. The number, location, and time of bracket failure was recorded for each light-curing unit over the first 9 months of treatment. Bond failure rates during this period were estimated for each unit. Statistical analysis was undertaken using the Pearson chi-square test, the three-parameter Weibull survival estimates, and the log-rank test.
RESULTS: Both light-curing units showed sufficiently low bond failure rates. The overall failure rate recorded with the halogen unit (3.33%) was not significantly different ($P = 0.0307$) compared with that with the LED unit (5%). A higher

bond failure rate was found in boys compared with girls ($P = 0.040$), in the mandibular dental arch compared with the maxillary ($P = 0.008$), and in the posterior segments compared with the anterior ($P = 0.037$). No statistically significant differences were found between right and left segments ($P = 0.838$). There was no significant difference in terms of bracket failure risk over an estimated period of 30 months between the brackets cured with the halogen lamp and those cured with the LED.
CONCLUSIONS: No significant differences were found in total bond failure rate between stainless steel brackets cured with a LED lamp and those cured with a halogen lamp, despite the different polymerization time used for the two devices. Thus, LED-curing units can be considered an advantageous alternative to conventional halogen sources as they enable the clinician to reduce bonding chair-time without significantly compromising the procedure.

162 COMPARISON OF THE EFFECTS OF ACTIVATOR AND ELASTODONTIC THERAPY

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AIM: To analyse the effects of functional treatment with an activator and an elastodontic appliance (occlus-o-guide®) on two groups of growing patients, in comparison with an untreated control.
SUBJECTS AND METHOD: Control (C) group (12 subjects, mean age 10 years) who declined activator therapy; treatment group A (16 subjects, mean age 9.8 years) in which activator therapy was undertaken; treatment group O (15 subjects, mean age 10.4 years) in which an occlus-o-guide® was used. The subjects for all groups satisfied the following selection criteria: 9-11 years of age, mixed dentition, Class II molar relationship, overjet >5 mm, overbite >3 mm, skeletal Class II malocclusion (ANB >4°), no history of previous orthodontic therapy. Radiographs from before (T0) and after (T1) treatment were analysed, particularly skeletal and dental sagittal and vertical cephalometric measurements.
RESULTS: Skeletal analysis: group A showed improved control of maxillary forward growth (Co-A: group A = 0.93, group O = 5.22, Olp-A: group A = 1.47, group O = 3.83). These results were also associated with upper incisor retroclination (FH^1: group A = 5.31, group O = –1.61) and confirmed by retraction of the upper lip (Olp-UL: group A = 1.78, group O = 5.67). Activator therapy seems to be more effective in overjet correction (overjet: group A = –4.57, group O = –2.00). Both treated groups showed skeletal mandibular advancement compared with group C (SNB: group A = 1.45, group O = 1.17, group C = 0.00; Olp-B: group A = 4.88, group O = 5.11, group C = 1.67; Olp-Pg: group A = 4.88, group O = 5.56, group C = 2.00). Both treated groups demonstrated a clockwise rotation of the palatal plane (SN^PP: group A = 1.24, group O = 0.83, group C = –0.67), an improvement of overjet (group A = –4.57, group O = –2.28, group C = –0.13) and overbite (group A = –0.98, group O = –1.72, group C = 3.34), and a buccal inclination of the lower incisor (IMPA: group A = 1.19, group O = 3.06, group C = –1.67).
CONCLUSIONS: Both activator and occlus-o-guide® appliances are effective in the correction of a Class II relationship, overjet and overbite. In the activator group it was also possible to obtain orthopaedic control of maxillary growth and a better projection of soft tissue pogonion.

163 CRANIOFACIAL ANALYSIS FOR MICE DEFICIENT IN MRF-2

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AIM: Gene targeting has resulted in a mutant mouse deficient in the DNA binding protein, modulator recognition factor-2 (Mrf-2). The primary phenotype of the Mrf-2 -/- mouse is leanness and growth retardation. However, visual inspection of these mutants reveals unusual craniofacial characteristics, with blunted snouts and relatively small cranial vaults. It was hypothesized that deficiency of the Mrf-2 homologue in mice results in a tissue-specific defect in skeletal and craniofacial development. Therefore, the objective of this study was to localize and quantify the structural differences in the craniofacial complex when comparing Mrf-2 -/- mutants, +/- heterozygotes, and +/+ wild type mice.
MATERIALS AND METHOD: The mice were examined at two different age groupings: 91 to 101 days and 171 to 193 days of age. Radiographs were made of the head of each animal from the superior and lateral views. Images were digitized and landmarks were identified. A series of linear and angular measurements were recorded and statistical analysis was undertaken. Procrustes and thin-plate spline analyses were also completed for a visual representation of the structural differences. To determine proportional differences, tibial lengths were also measured.
RESULTS: According to cephalometric analysis, there were statistically significant differences between the mutant mice and the heterozygous and wild type mice in nasal length, cranial vault length, and cranial vault width. These differences increased with age. Geometric morphometrics confirmed these findings. Comparison with tibial length measurements indicated that the differences in cranial vault size were proportional to overall body size, but that differences in the size of the nasomaxillary complex were not proportional.

CONCLUSION: The unusual craniofacial phenotype of the Mrf-2 deficient mutant mouse is a result of disproportionate size discrepancies in selected craniofacial structures. These structural differences may result from loss of the specific activity of Mrf-2 on craniofacial or skeletal tissues.

164 ORTHODONTIC MANAGEMENT OF PATIENTS WITH CLEIDOCRANIAL DYSPLASIA**

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AIM: Treatment of patients with cleidocranial dysplasia (CCD) is complex and requires interdisciplinary therapy. Currently, neither recommendations for a structured treatment procedure nor data on patient treatment motivation or expectations are available. The aim of this study was to evaluate the treatment management of patients with CCD at the Medical Center of the University of Regensburg.
SUBJECTS AND METHOD: Twenty-eight registered patients with CCD; for nine initial clinical findings were available; 19 patients were treated externally. Dental and skeletal parameters as well as orthodontic treatment management were evaluated retrospectively. Supernumerary and malformed teeth, as well as persisting primary teeth were recorded and the frequency of these findings was depicted for each tooth. Treatment duration, extended treatment and interdisciplinary therapy was documented. The Peer Assessment Rating index was determined at the beginning and end of treatment. Treatment motivation, expectations of patients and their parents, and patient's satisfaction were evaluated using the SF 36 questionnaire according to Becker *et al*.
RESULTS: Dental and roentgenologic findings were inhomogeneous. Supernumerary teeth were frequently found in the premolar areas. CCD treatment takes a long time, is extensive and requires numerous surgical interventions, and partly prosthetic care. Treatment duration and the extent of medical care are increased. Treatment results should be interpreted in terms of an individual optimum. Most patients are satisfied with the outcome.
CONCLUSIONS: Due to the special characteristics, patients with CCD require an interdisciplinary treatment approach including orthodontics, prosthetics and oral and maxillofacial surgery. A comprehensive survey on the clinician's effort and medical care is extensive and difficult to achieve. Structured treatment must include individual developmental and achieved treatment phases.

165 TREATMENT EFFECTS OF MINISCREW ASSISTED PALATAL EXPANSION IN YOUNG ADULTS

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AIM: Non-surgical palatal expansion for maxillary constriction in post-pubertal adults may lead to periodontal complications and relapse. In order to facilitate true skeletal expansion, a miniscrew-assisted palatal expander (MA-RPE) was devised and a prospective study was performed to compare its treatment effects to those of conventional RPE in adolescent patients.
SUBJECTS AND METHOD: Fifteen children (mean age 10.2 years) treated with RPE and 17 adults (mean age 19.6 years) whose therapy was undertaken with the MA-RPE. Postero-anterior and periapical radiographs, and dental casts were taken before and after active expansion.
RESULTS: Suture opening was found in 88 per cent of the adults and in 100 per cent of children. The skeletal and dentoalveolar changes after expansion were statistically significant in both groups. The change in the basal bone was slightly greater in the child group. However, the amount of buccal tipping during expansion was similar in both groups.
CONCLUSION: Orthopaedic palatal expansion in adults can be reliably performed by the incorporation of miniscrews.

166 BIOMECHANICAL EFFECT OF MAXILLARY PROTRACTION USING MINIPLATE ANCHORAGE

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AIM: Facemask therapy has been used in the treatment of patients with Class III malocclusions and maxillary deficiency. Traditionally, tooth-borne devices such as the banded or bonded rapid maxillary expansion (RME) appliance have been used as intraoral anchorage for maxillary protraction. Recently, skeletal anchorage (e.g. miniscrews or miniplates) has been used as absolute anchorage for orthodontic tooth movement, and orthopaedic application of this for maxillary protraction can be considered. The aim of this study was to evaluate the biomechanical effects of maxillary protraction using miniplate and RME anchorage on the maxillofacial complex using a three-dimensional (3D) finite element model (FEM) of the craniofacial skeleton.
MATERIALS AND METHOD: The construction of the 3D FEM was based on computer tomography scans of the skull of a 13.5 year-old female with a retruded maxilla and anterior crossbite. For the convenience of analysis, only the left side of

the cranium was modelled. The 3D FEM consisted of 329,752 elements and 67,011 nodes. For loading conditions, maxillary protraction forces were applied to the end area of the miniplate anchorage and the hook of the RME appliance. An anteriorly directed force of 500 g was loaded in a 30 degree obliquely downward direction to the functional maxillary occlusal plane.
RESULTS: Anterior displacement of the maxilla was observed in both models. The RME model showed more counterclockwise rotation of the maxilla than the miniplate model, resulting in less anterior displacement on the nasion area. The von Mises stresses were more prominent in the bones around the frontonasal, frontomaxillary and zygomaticotemporal sutures and the pterygomaxillary fissure than the other sutures in both models. von Mises stresses in the cranial base were higher in the greater wing of the sphenoid bone, superior orbital fissure, jugular and lacerated foramen.
CONCLUSIONS: The miniplate model showed less counterclockwise rotation of the maxilla than the RME model. von Mises stress was concentrated on the sphenoid bone except in the circummaxillary suture in both models, implying a possible orthopaedic effect in the cranial base area.

167 PATIENTS' PERCEPTIONS OF MICRO-IMPLANTS AS ORTHODONTIC ANCHORAGE

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AIM: In orthodontics, the paradigm is shifting since the introduction of micro-implants as anchorage units. However, patients' perceptions and acceptance of micro-implants is not fully understood. The aims of this investigation were to examine patients' levels of pain in micro-implant surgery both intra- and post-operatively compared with other orthodontic procedures, and to investigate their perception and acceptance of this technique.
MATERIALS AND METHOD: Seventy-eight micro-implants (Dentos, Absoanchor® System) were placed in 37 patients (13 males, 24 females, mean age: 23.5 years) as anchorage units. This study consisted of two parts: (1) Level of pain perceived by patients undergoing various orthodontic procedures, including separation, initial tooth alignment and micro-implant surgery, were rated by visual analogue scale corresponding to the level of pain expected and perceived in various procedures, and pain experienced over a 7-day period post-operatively. (2) Questionnaires concerning the patients' post-operative perceptions, functional disturbance and satisfaction with micro-implant treatment were collected one month after micro-implant insertion.
RESULTS: The expected level of pain was significantly higher than that experienced during micro-implant surgery ($P < 0.001$); in contrast to separation and initial tooth alignment procedures, where the pain level experienced was similar to that of patients' expectations ($P > 0.05$). Post-operative pain experienced following one week decreased continuously from day 1 to day 7 in all procedures. The total area under curve of initial tooth alignment over the 7-day period was significantly larger than that of separation and micro-implant surgery ($P < 0.05$). The questionnaire study showed that 94.9 per cent of patients reported only moderate pain or even less during micro-implant surgery. Satisfaction was expressed by 75.8 per cent of patients with micro-implant treatment who would consider the treatment again if necessary, and 77.8 per cent of patients would recommend micro-implants to friends and relatives.
CONCLUSIONS: (1) Subjects significantly over-estimated the pain level of micro-implant surgery (2) The pain perceived one week post-operatively of micro-implant surgery is lower than that of initial tooth alignment. (3) Micro-implants as anchorage in orthodontics is highly accepted and welcomed by orthodontic patients as they caused minimal post-operative discomfort.

168 'GENOTYPIC SHUFFLING' OF *CANDIDA ALBICANS* IN FIXED APPLIANCE PATIENTS

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AIM: To analyze the genotypes of sequential clones of *C. albicans* in a cohort of consistent candidal 'carriers' during fixed orthodontic appliance (FOA) therapy.
SUBJECTS AND METHOD: Eleven (16.3 ± 3.9 years of age) of 97 consecutive patients who underwent FOA therapy and were consistent candidal carriers during the study period of 12 months. Candida isolates from baseline samples prior to FOA insertion (T0) and sequential visits after insertion (T1 to T10) were speciated using the germ tube test and Analytical Profile Index ID32C yeast identification system (bioMerieux®). The random amplification of polymorphic DNA (RAPD) fingerprint patterns of each of the 103 sequential *C. albicans* isolates collected were analyzed using standard protocols for polymerase chain reaction (PCR) and gel electrophoresis. For the PCR analyses, the primer RSD-11 (5' - GCA TAT CAA TAA GCG GAG GAA AAG - 3') was used. Dendrogram analysis of the RAPD gel profiles revealed the similarity of the profiles of *C. albicans* by clustering the isolates on the basis of their genetic relatedness to each other. A similarity coefficient (S[ab]) for each pair of strains was calculated and S[ab] of 0.80 was used as threshold for clustering of similar strains. Dendrogram profiles of all *C. albicans* isolates of the carriers were analyzed individually and as a composite group.

RESULTS: In nine patients the genotypes of sequentially isolated *C. albicans* showed minor variations in profile on sequential isolation over the study period, implying 'genotypic shuffling' within one genetic group during FOA therapy. Genotypes of two patients, however, were notably disparate and showed major genetic shifts.
CONCLUSIONS: Genotypic shuffling of *C. albicans* in carriers occurs during FOA therapy. *C. albicans* appear to survive within the oral cavity of carriers during FOA therapy, possibly through the mechanism of genotypic shuffling. The composite dendrogram of all *C. albicans* isolates indicated that the Candida populations in this cohort are genotypically dissimilar although collected from the same geographic locale and a similar healthy, age group.

169 FACTORS REGULATING ENDOCHONDRAL OSSIFICATION IN SPHENO-OCCIPITAL SYNCHONDROSIS

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AIM: The spheno-occipital synchondrosis is an important growth centre of the craniofacial skeleton. It is influential on the position of both the maxilla and mandible. During the post-natal period, endochondral ossification of the synchondrosis contributes largely to the expansion of the ossification centres and growth of the cranial base. Endochondral ossification plays a major role in bone formation, which can be traced by the expression of stage specific markers. Core binding factor alpha 1 (Cbfa1) is a key transcription factor and known to be associated with chondrocyte maturation and osteoblast differentiation. Vascular endothelial growth factor (VEGF) is a regulator of vascularization, and its maximum level of expression precedes the maximum level of new bone formation during endochondral ossification in the long bone and the condyle. The factors governing growth of the synchondrosis are not fully elucidated. Whether growth of synchondrosis can be affected by mechanical stress is still unclear. It is important to understand the mechanism of Cbfa1 and VEGF underlying the development of synchondrosis, and to correlate their expressions. The aim of this study was to establish the temporal pattern of Cbfa1 and VEGF expressions in response to mechanical stress, and to correlate Cbfa1 and VEGF expression of spheno-occipital synchondrosis.
MATERIALS AND METHOD: Sixty male balb/c mice were randomly divided into six experimental and six control groups corresponding to five time points. The animals were sacrificed and cranial base synchondroses were aseptically removed. Mechanical stresses were applied on the experimental surgical explants with helical springs and incubated in organ culture for 6, 24, 48, 72 and 168 hours. Tissue sections were subjected to immunohistochemical staining for quantitative analysis of Cbfa1 and VEGF expression.
RESULTS: Quantitative analysis revealed that Cbfa1 and VEGF expression reached a peak increase at 24 and 48 hours, respectively. Compared with the control groups, both Cbfa1 and VEGF were expressed consistently higher in the experimental group at all time points.
CONCLUSION: Mechanical stress applied on the synchondrosis elicits Cbfa1 expression, and subsequently up-regulates the expression of VEGF. These factors act in a synchondronized manner to control the maturation of chondrocytes into hypertrophic chondrocytes and also induce chondroclast invasion and osteoblast formation, resulting in more new bone leading to growth of the spheno-occipital synchondrosis.

170 EFFECTS OF NICOTINE ON TOOTH MOVEMENT – A MICROSTRUCTURAL ANALYSIS

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AIM: The deleterious effects of nicotine are not restricted to the tissues directly in contact with this substance. It has a detrimental effect on bone structure that may lead to osteoporosis and generalized bone loss. The aim of this study was to investigate the effects of nicotine on orthodontic tooth movement.
MATERIALS AND METHOD: Eighty-eight out-bred male Wistar rats weighing, on average, 500 g were randomly divided into four groups: a nicotine treated group (3.0 mg/kg/day), a tobacco extract, tobacco extract and nicotine, and a water control. All substances were added to drinking water. After six weeks of exposure, a 10 g Sentalloy orthodontic closed coil was inserted between the upper left first molars and upper incisors. The spring was left in place for 21 days in order to generate a mesial movement of the first molar. A split-mouth design was used with the untreated contralateral side serving as the control. Fluorescent labelling of bone apposition sites were accomplished by injecting the animals intraperitoneally with tetracycline and calcein 7 and 2 days before sacrifice. Histomorphometric analysis of the tissues surrounding the mesial root of the treated and untreated side was performed to determine the alveolar socket area, extension of alveolar wall erosion surfaces, double and single labelled surfaces, trabecular bone volume, percentage of eroded and formation surfaces, mineralizing surface in trabecular bone and mineral appositional rate.
RESULTS: The preliminary results demonstrate that nicotine and tobacco extract may have a detrimental effect on bone remodelling activity.

171 STABILITY OF CONNECTED MICRO-IMPLANTS AND MINIPLATES FOR SKELETAL ANCHORAGE

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AIM: Use of skeletal anchorage in orthodontics has gained increasing popularity in both clinical applications and research. The indications for skeletal anchorage range from intrusion of an individual tooth to retraction of the whole dentition, and even orthopaedic movement. However, no study has examined the stability of connected micro-implants. The aim of this investigation was to examine the stability of the connected micro-implants and miniplates.

MATERIALS AND METHOD: Three different skeletal anchorage systems were investigated; 1) two 1.5 mm diameter cylindrical micro-implants connected with a 0.021 × 0.025 inch stainless steel (SS) wire, 2) two 1.6 mm diameter tapered micro-implants connected with a 0.021 × 0.025 inch SS wire and 3) two 2 mm diameter cylindrical micro-implants connected by a titanium locking miniplate. The connected micro-implants were fixed on standardized bovine bone specimens. The connected systems underwent uniaxial pull-out tests at the midpoint of the connecting wire/miniplate by a mechanical testing machine (Instron, model 1185). Statistical analysis, one-way ANOVA, was used to determine differences in the pull-out test results between the different groups.

RESULTS: Both the connecting titanium miniplate and SS wire connection systems showed severe deformation causing damage at the screw head which broke before the micro-implants failed. The titanium locking miniplate system showed the highest pullout force (529 N) compared with the other two wire connection systems ($P < 0.001$). The threads in the screw head and the plate holes in the miniplate locking system were advantageous in transmitting force to micro-implants compared with using SS archwire and composite resin, as the latter fractured at lower force. The 2 mm miniplate connected micro-implants were also stiffer than the 1.6 and 1.5 mm systems ($P < 0.001$). The yield force of the 2-mm miniplate (153 N) was significantly higher than the 1.5 mm (88 N) and 1.6 mm (76 N) systems ($P < 0.001$). The high yield force and stiffness of the miniplate system might well withstand intraoral masticatory and orthodontic force without any deformation.

CONCLUSION: This *in vitro* study demonstrated that connecting two micro-implants with a miniplate results in greater stiffness and yield force. This aids resistance to force and deformation, thus providing a more stable system for orthodontic skeletal anchorage.

172 CRANIOFACIAL MORPHOLOGY IN X-LINKED HYPOHIDROTIC ECTODERMAL DYSPLASIA

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AIM: To analyse craniofacial morphology in adult males and females with X-linked hypohidrotic ectodermal dysplasia (HED) and comparison with normative data.

SUBJECTS AND METHOD: Ten males and 33 females (mean age 34 and 42 years, respectively) with a known mutation in the ED1 gene. The mean number of missing teeth was 22 (16-26) for males and four (0-20) for females. Twenty-seven reference points were marked and digitized directly on lateral cephalograms. Data were analysed using the software package, TIOPS. Control data came from 102 healthy males and 51 healthy females. Differences between the mean values were tested using a Student's *t*-test. The level of significance was set at 1 per cent.

RESULTS: The size of the cranial base was within normal limits for both HED groups. The mean cranial base angle was normal in affected males, but significantly increased in female carriers. The length of the nasal bone was normal. However, the nasal bone was retroclined in both HED groups; most pronounced in the males. The length of the maxilla and maxillary prognathism were reduced in both HED groups. In addition, in the affected males, the maxilla was significantly more anteriorly inclined than in the controls. The length, posterior height and gonial angle of the mandible were within normal limits for both groups. However, in affected males the mandible was significantly more anteriorly inclined and the mandibular prognathism was increased compared with the controls. The sagittal jaw relationship was decreased, especially in males. A short and flat nose, protruding lips, protruding chin and reduced face height, characterized the soft tissue facial profile in affected males. In female carriers, the soft tissue profile was less remarkable, except that the lips were significantly retruded compared with the controls.

CONCLUSION: Significant deviations were found in the skeletal facial morphology of both affected male and female carriers, especially males. The large number of missing teeth could explain most of the deviations, but, in addition, the HED subjects showed changes in the inclination of the nasal bone and in maxillary prognathism and inclination. The overall size and shape of the mandible were normal despite the large number of missing teeth. Furthermore, the nose was short and somewhat flat in the HED males; combined with protruding lips and chin and markedly reduced face height, this led to a rather characteristic soft tissue facial profile.

173 CEPHALOMETRIC VALUES OF CHILDREN WITH JUVENILE IDIOPATHIC ARTHRITIS

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AIM: Besides all other joints, juvenile idiopathic arthritis (JIA) also affects the temporomandibular joints (TMJ). In severe cases it can lead to a progressive destruction of the condylar process of the mandible. Several studies have described changes of cephalometric values in this patient group. Prevalence of JIA is approximately 80/100,000, with girls more often affected than boys. The aim of this study was to analyse the cephalograms of patients suffering from JIA.
MATERIALS AND METHOD: Thirty-nine cephalograms (32 females, 7 males) of patients with JIA between 7 and 18 years of age were available for analysis. All cephalograms were traced twice by one examiner. Each tracing was digitized twice to determine tracing errors, and the digitizing process. SNA, SNB, ANB, SN-NL, SN-ML, NL-ML, the relationship of posterior to anterior face height, ArGoMe, and the upper to lower face height index were determined. Twenty-eight magnetic resonance images (MRI) of the TMJ were also available for analysis of inflammatory degenerative processes.
RESULTS: The method error for tracing ranged from 0.3 degrees (ANB) to 0.8 degrees (ArGoMe), and for digitizing from 0.1 (ANB) to 0.2 (ArGoMe) degrees. The small number of cephalograms available per age group and gender did not allow appropriate statistical analysis. Therefore, the results were compared only with norm values of children available from the study of Droschl (1984). Most of the profiles were not significantly affected by the rheumatic disease, however some patients showed a severe retrognathic profile. This was a result of the clockwise rotation of the mandible caused by diminished condylar growth and/or a progressive destruction of the condyles. For these profiles, SNB, ANB, SN-ML and NL-ML values were highly increased. On the other hand, the relationship of posterior to anterior face height was greatly decreased. In these cases the measured values exceeded the maximum and minimum age-related values measured by Droschl in untreated children. For 23 of the 28 available MRIs, signal enhanced regions could be observed in the TMJs, indicating pathological activity.
CONCLUSION: Most patients in this study were within the norm values for their age group. However, condylar destruction in patients with JIA can lead to highly retrognathic profiles due to a clockwise rotation of the mandible.

174 SURVIVAL OF BONDED STAINLESS STEEL LINGUAL RETAINERS: A HISTORIC COHORT STUDY

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AIM: The objective of this historic cohort study was to evaluate the clinical survival of bonded stainless steel lingual retainers at the end of orthodontic treatment between 2002 and 2006.
SUBJECTS AND METHOD: Two hundred and seventy seven patients [162 females; median age 14.8 years, interquartile range (IQR): 13.6; 16.5 years, and 115 males; median age: 15.3 years, IQR: 14.2; 16.7 years]. After acid etching and bonding agent application, bonded retainers (Quad Cat® stainless steel, twisted wire, 0.022 × 0.016 inch, GAC International, New York, USA) were applied using a flowable resin composite (Tetric Flow). Data concerning failures, gender, age of the patient, and operator experience were retrieved from the patient files. The maximum observation time was 41 months. While 116 patients were treated with removable functional and fixed appliances (combined treatment), 161 patients had their treatment only with fixed appliances. A modified maxillary Hawley retainer was worn by 258 patients after completion of orthodontic treatment. This device was worn for a period of 1 year. Nineteen patients in this group received a bonded retainer in the maxilla between the lateral incisors (2-2). All 277 patients received a lower bonded retainer from canine to canine.
RESULTS: Ninety-nine debonding (35.7%), two fractures (0.7%) and four debonding and fracture (1.4%) events were observed. No significant effect of gender (females: 41%, males: 32%), age of the patient (<16 years: 37%, >16 years 38.7%) and operator experience (less experienced: 38%; moderate experience: 28.9%, professional: 46.7%) on failure rate was found ($P < 0.05$; Log rank test). Kaplan Meier survival curves showed a 63 per cent success rate for the bonded lingual retainers in 41 months.
CONCLUSION: The success rate of the bonded lingual retainers was 63 per cent in 41 months, with most failures occurring during the first 6 months. Gender and age of the patient, and operator experience did not affect the failure rate.

175 ANALYSIS OF ARCHFORM CHANGES ASSOCIATED WITH CLASS I, II, AND III ORTHODONTIC TREATMENT

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AIM: To compare dental archform changes associated with orthodontic extraction therapy in subjects with a Class I, Class II division 1 and Class III malocclusions.

MATERIALS AND METHOD: Pre- and post-treatment dental models obtained from patients with Class I (n = 20), Class II division 1 (n = 20), and Class III (n = 18) malocclusions, matched for age and gender. The patients had undergone non-surgical premolar extraction orthodontic therapy. The study models were scanned using the Minolta Vivid 900 non-contact laser scanner. A customized computer software program was used to digitize and quantitatively measure arch ratio (arch depth/arch width) and coefficients of the fourth polynomial curve. Qualitative assessment of dental arch shape was performed by two operators based on the OrthoForm template (3M Unitek) which categorised arch forms into taper, ovoid or square. Statistical analyses were performed using ANOVA and *t*-tests. Method error was checked by Bland Altman analysis.
RESULTS: Intraclass pre- and post-treatment comparisons showed that the arch ratios of both the maxillary and mandibular dental arches decreased significantly in the treatment of Class I, Class II division 1 and Class III malocclusions. Pre-treatment comparisons showed that Class I maxillary arches had significantly smaller arch ratios when compared with Class II division 1, but no difference with Class III. Both maxillary and mandibular dental arch forms were altered from a square to an ovoid shape in the treatment of Class I malocclusions. Pre-treatment Class II maxillary arches showed significantly larger arch ratios when compared with Class I and Class III. Pre-treatment Class II maxillary arches had tapered arch forms that were either maintained or altered to an ovoid shape post-treatment. Pre-treatment Class II mandibular arch forms were altered from an ovoid to a tapered form post-treatment. Pre-treatment Class III maxillary arches showed significantly smaller arch ratios when compared with Class II maxillary arches. Pre-treatment Class III maxillary arches remained tapered or altered to ovoid archforms post-treatment. Pre-treatment mandibular archforms were altered from an ovoid to a tapered form post-treatment.
CONCLUSION: Orthodontic premolar extraction therapy in Class I, Class II division 1 and Class III malocclusions resulted in decreased arch ratios. The original pre-treatment dental archform was not consistently maintained post-treatment in all three Classes of malocclusions.

176 PARATHYROID HORMONE EXPOSURE OF PERIODONTAL LIGAMENT CELLS MODIFIES THE FORMATION AND ACTIVITY OF OSTEOCLASTS

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AIM: To elucidate the role of human periodontal ligament (PDL) cells in dental hard tissue repair, it was hypothesized that an intermittent parathyroid hormone (PTH) challenge of PDL cells would result in physiologically relevant changes in the expression of osteoprotegerin (OPG). This protein, as part of the RANK/RANKL/OPG system, has been identified as a key regulatory factor of hard tissue remodelling.
MATERIALS AND METHOD: Human PDL cells were cultured from premolars extracted for orthodontic reasons. Pre-confluent, as well as confluent cells, were exposed to 10-12M PTH(1-34) intermittently. Such a pulsatile treatment regimen has been shown to exert potentially anabolic effects on bone metabolism. At harvest, cell number and OPG levels were determined in the conditioned media. To examine the influence of the modified OPG levels in the conditioned media on the formation of osteoclasts, mononuclear osteoclastic precursor cells were cultured in the presence of the conditioned media, forming osteoclasts were visualized by staining for tartrate-resistant acid phosphatase (TRAP) and quantified by means of histomorphometry. Analogous to this approach, the impact of such conditioned media on the resorptive activity of osteoclasts was determined on calcium phosphate sputtered slides.
RESULTS: An intermittent PTH(1-34) stimulation of PDL cells resulted in a maturation-state dependent modification of OPG production. The reduction of OPG levels in response to PTH(1-34) observed in more mature cells led to a significant increase in TRAP-positive cells as well as to an increased resorption of the substrate. The opposite held true for the conditioned media obtained from less mature pre-confluent PDL cells. Culturing osteoclastic precursors in the presence of such media expressing increased levels of OPG significantly inhibited the differentiation and activity of osteoclasts.
CONCLUSIONS: PTH(1-34) induced changes in OPG production by human PDL cells are of physiological relevance and actually result in a modification of the formation and resorptive capacity of osteoclasts *in vitro*. These findings might be of importance in influencing reparative processes following inflammatory periodontal disease or reparative cementum formation in the course of root resorption induced by orthodontic tooth movement.

177 MICROBIOLOGY OF BIOFILMS ON ORTHODONTIC ALIGNING APPLIANCES IN 'FAST' PLAQUE FORMERS

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AIM: To determine the bacterial flora of the biofilms of Invisalign® appliances over a 14 day period.

SUBJECTS AND METHOD: Fifty-six volunteer dental students (mean age 21.3 years) were instructed to refrain from oral hygiene procedures for 48 hours. Digital photographs were taken post-plaque disclosure of the six anterior maxillary teeth, and the percentage area of plaque coverage was determined using image analysis. The seven subjects with the highest plaque coverage over 48 hours were determined as 'fast' plaque formers. The subjects then wore a 'novel' full coverage splint with four Invisalign tiles embedded and were instructed to perform oral hygiene as normal, and to clean the appliance daily. The tiles were harvested at intervals of 1, 3, 7 and 14 days. The biofilms formed were suspended in reduced transport fluid, serially diluted and plated on to blood agar plates that were incubated under aerobic and anaerobic conditions. Bacterial species were identified using conventional microbiological techniques including microscopy, aerotolerance and gram staining procedures.
RESULTS: Bacterial biofilms of Invisalign appliances were found to be multi-species, with an average of 9-11 species per patient. The results showed a trend of initial colonizing bacteria over a 24 hour period being predominantly gram positive species with a larger proportion (71% aerobic, 64% anaerobic) comprising gram positive cocci species. After 72 hours, the bacterial fauna underwent a shift with an increase in the number of rod and coccobacillus species (8.75 to 17.5%). Gram staining characteristics of the bacteria showed a predominantly gram positive population of bacteria during the early periods of biofilm development (78%), progressively changing to a more gram negative flora with increasing biofilm age. By day 14, 43 per cent of aerobic bacterial species were gram negative. Most of the aerobic bacteria isolated over the 7 day period were mostly facultative aerobes capable of growing in both oxygenated and oxygen-deprived environments.
CONCLUSION: Bacterial biofilms form on Invisalign surfaces, even in patients who undergo oral and appliance hygiene. These biofilms comprise numerous species, and undergo changes in the compositional flora and characteristics over a 14 day period.

178 ARCHITECTURE OF BIOFILMS ON AN ALIGNING APPLIANCE: A SCANNING ELECTRON MICROSCOPIC INVESTIGATION

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AIM: To investigate, using scanning electron microscopy (SEM), the architectural characteristics of biofilms on Invisalign® appliances over a 14 day period.
SUBJECTS AND METHOD: Fifty-six volunteer dental students (mean age 21.3 years), instructed to refrain from oral hygiene procedures for 48 hour period. Digital photographs were taken post-plaque disclosure of the six anterior maxillary teeth, and the percentage area of plaque coverage determined using image analysis. The seven subjects with the highest plaque coverage over 48 hours were determined as 'fast' plaque formers. The subject for this investigation was chosen from a pool of fast plaque formers. The subject was instructed to wear an Invisalign appliance, and at intervals of 1, 3, 7, and 14 days and resume normal oral hygiene as well as appliance cleaning procedures. The collected appliance was sectioned, sputter coated with elemental gold and the inner surfaces scanned via SEM to visualize the morphological and structural characteristics of the biofilms. The morphology of the Invisalign appliance itself with its macro and microscopic corrugated surface was also visualized by SEM, with the furrowed surface due to the stereolithography modality of production of the study models used to fabricate the aligners.
RESULTS: Over the initial 24 hour period, the initial colonization was clearly seen to be initiated by rod and coccal pioneer species. The distribution of the fledging biofilm was mostly centred around the raised portions of the appliance, possibly due to the increased surface roughness. By 72 hours, a substantial increase in biofilm mass was visible, with growth overflowing into the recessed areas of the furrowed surface. Copious quantities of extracellular polymeric substance (EPS) that developed appeared to strengthen the colony structure and bind individual bacteria. By 14 days, complex communities of bacteria were visible, arranged in three-dimensional tower structures, together with large aqueous channels interlaced within the EPS matrix.
CONCLUSIONS: The development of biofilms on the Invisalign® appliance appears to be analogous to naturally occurring dental biofilms, in terms of development and architectural characteristics. The surface configuration of the appliance appears to contribute to the pattern and distribution of early biofilm formation.

179 EXPERIMENTAL STUDY OF ADHESIVE STABILITY OF AESTHETIC BRACKETS DURING DEBONDING

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AIM: To test a novel type of aesthetic self-ligating bracket (Opal/Ultradent) made of glass fibre fortified plastic on adhesive stability and risk potential in debonding, and to compare it with ceramic brackets and a standard metal bracket.

MATERIALS AND METHOD: Apart from the Opal-Bracket (Ultradent), four ceramic brackets [Clarity (3M), Fascination 2 (Dentaurum), Aspire (Forestadent), Inspire Ice (Ormco)] and a metal bracket (Victory, 3M), which served as the control, were tested. According to the manufacturers' instructions, the brackets were fixed with adhesive on germectomized human wisdom teeth and afterwards removed by an automatic shearing device. The distance to shearing and the power necessary were digitally recorded. On the basis of bracket base area, the shear bond strength and the distance necessary for adhesive stability in megapascals (MPa) were compared. Additionally enamel defects on the tooth surfaces were microscopically examined.
RESULTS: The metal bracket showed a medium adhesive stability of 10.19 MPa. The Opal bracket, at 4.17 MPa, had the lowest average bond strength. At 12.4 MPa (Clarity), 14.4 MPa (Aspire) and 15.375 MPa (Inspire Ice), the ceramic brackets, reached similar adhesive values without leading to hard tissue defects. For Fascination 2, with an adhesive power of 19.79 MPa, splitting of enamel was found after debonding approximately one-third of the sample.
CONCLUSION: Compared with the literature, the adhesive stability of the Opal bracket appears to be too low for safe clinical use. The adhesive power of Fascination 2 has to be rated as too strong for safe debonding because of the possibility of enamel fracture. The other ceramic brackets show a good relationship between safe removal and sufficient adhesive compound.

180 IS WHAT WE TEACH WORKING? AUDIT AS A TOOL TO ASSESS LONG-TERM TEACHING OUTCOMES

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AIMS: Appropriate referrals require good diagnostic skills yet a Europe-wide shortage of dental academics exists with increasing pressure on the curriculum. This baseline audit assessed the accuracy, appropriateness and completeness of orthodontic patient referrals using a referral proforma.
MATERIALS AND METHOD: A prospective two-centred, hospital-based clinical audit was set up at Leeds Dental Institute and Seacroft Hospital orthodontic departments. A specially designed orthodontic referral proforma (ORP) was sent to all local general dental practitioners (GDPs) for patient referral to the orthodontic departments. The ORP requested key administrative, dental and orthodontic information. A sample-size calculation was performed. Data was collected for 262 consecutively referred patients from 118 GDPs during their initial assessment by an orthodontic consultant. Undiagnosed pathology and the outcome of the consultation was recorded. The GDPs' and consultants' assessments were compared. The gold standards were: 100 per cent of the sections on the ORP should be completed; there should be 'good' inter-examiner agreement (kappa >0.6) between GDPs and orthodontic consultants; 80 per cent of patients should be 'appropriate' referrals.
RESULTS AND DISCUSSION: Only 59 per cent of sections on the ORP were completed and up to 11 per cent of details were incomplete. Skeletal Class, dental history, overjet, missing teeth and teeth of poor prognosis were poorly completed. Only the 'dental history' field reached a good level of agreement (kappa > 0.6); 35 per cent of patients presented with undiagnosed dental pathology; 45 per cent of the sample were deemed appropriate referrals; 22 per cent were 'early' referrals but 33 per cent were 'inappropriate' referrals. The gold standards were not met. Other studies have investigated ORPs to improve referral practice but few have used audit as a way of assessing the quality of teaching outcomes in practice despite the widespread shortage of dental academics.
CONCLUSIONS: Local standards of orthodontic referral are poor. Measures needed to address this include: increased resources for appropriate academic training/staffing in dental schools for undergraduate (UG)/postgraduate (PG) training; review undergraduate admission procedures and teaching of key skills in all specialties at UG/PG levels; disseminate results to local GDPs; provide advice on how to complete the ORP; re-audit following implementation of the recommended action points.

181 THREE-DIMENSIONAL MAXILLARY ARCH CURVATURE CHANGES – A PRINCIPAL COMPONENTS ANALYSIS

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AIM: To correlate three-dimensional (3D) modification of the maxillary arch curvature, assessed frontally, with simultaneous lateral cephalometric changes after fixed orthodontic treatment.
MATERIALS AND METHOD: Pre- and post-treatment lateral cephalograms of 31 subjects with Class II division 1 malocclusions were digitized. The anterior occlusal plane (AOP), functional occlusal plane (FOP) and upper incisor

(U1) inclinations relative to the sella-nasion (SN) line were measured. Utilizing a proprietary software, 3DM® (National University of Singapore), laser scanned virtual 3D models of pre- and post-treatment maxillary dental plaster casts were aligned antero-posteriorly and vertically along the mid-palatal suture and transversely across a reference horizontal plane to the respective pre- and post-lateral cephalograms; subsequent two-dimensional superimposition of the aligned lateral cephalograms facilitated the 3D superimposition of aligned pre- and post-virtual models to evaluate 3D curvature changes quantitatively. Principal components analysis (PCA) was utilized to identify patterns of changes from a 3D perspective, highlighting the differential effect in the contribution of each of the three cephalometric variables, which when changes occur simultaneously as a component, could possibly modify the 3D maxillary arch curvature. Univariate linear regression analysis was utilized to determine the statistical significance of the differential effect of each cephalometric variable within the components yielded from the PCA ($P < 0.05$).
RESULTS: Of the three components derived from the PCA, only the 3D pattern demonstrating a larger positive change in SN-AOP angle and a simultaneous moderate negative change in U1-SN angle resulted in a positive curvature change of 1.93 degrees (95% CI 0.37 to 3.50, $P = 0.017$). Conversely, the component demonstrating a pattern with a larger positive change in U1-SN angle and simultaneous moderate negative change in SN-AOP angle was near statistical significance for a negative curvature change of 1.55 degrees ($P = 0.06$). The last component demonstrating a larger positive change in SN-FOP angle and minimal changes in the SN-AOP and U1-SN angles was not statistically significant ($P = 0.39$).
CONCLUSION: The magnitude of the 3D maxillary arch curvature assessed frontally is related more significantly to AOP orientation and to a lesser degree, inversely to maxillary incisors inclination.

182 PREDICTION AND PREVENTION OF ROOT RESORPTION AND TREATMENT APPROACHES
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AIM: To estimate the 'quality standards' of orthodontic treatment in the Department of Orthodontics of Gothenburg University, regarding the prediction and prevention of root resorption evaluated on radiographs, and the differentiation of treatment approaches in subjects with root resorption.
MATERIALS AND METHOD: The general and radiographic records of patients who had finished active treatment with fixed or removable appliances during 2004. The factors studied included: i) the presence of history records; ii) radiographic examination before treatment; iii) the frequency of radiographic examinations performed; iv) the prevalence of moderate or severe root resorption reported; v) treatment reassessment approaches reported after the diagnosis of moderate or severe root resorption
RESULTS: Sixty per cent of the practitioners kept history records. Before treatment, 40 per cent periapical, 60 per cent panoramic and 20 per cent cephalometric radiographs had been taken. Fifteen per cent of the cases had been followed radiographically after 6 months of treatment and 40 per cent at the end. Around 10-15 per cent of cases had been reported for moderate, and around 3 per cent for severe root resorption after treatment. The most common approach if root resorption was evident was the use of longer intervals and resting periods and the decrease of total duration.
CONCLUSIONS: The protocols provided in the literature were not used in practice regarding investigation of history and radiographic follow-up. Treatment recommendations seem to be more generally adopted.

183 OCCUPATIONAL DISEASES AFFECTING ORTHODONTISTS
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AIM: To investigate the prevalence of diseases reportedly associated with the practice of orthodontics in a group of specialists, and to advise on adequate preventive measures.
SUBJECTS AND METHOD: A questionnaire on professional diseases was carried out after a detailed review of the literature. The questionnaire was sent to the 63 orthodontists listed in the specialist register in the area of Strasbourg, France. Fifty-one were returned, making the return rate 81 per cent. The mean practice experience in the group was 21 ± 9 years.
RESULTS: Seventy-one per cent of the orthodontists who responded to the questionnaire had suffered or were still suffering from occupational problems related to their professional practice. The most frequent problems were musculoskeletal (81%), dermatosis (44%) and allergic dermatitis consisting of skin inflammation following contact with acrylic and composites resins or latex (36%). Females had a higher rate of occupational disease (75%) than males (66%). The results highlighted the role of the duration of the professional occupation: Ninety-one per cent of the orthodontists practicing for more than 30 years reported occupational diseases while only 33 per cent of the orthodontists with careers less than 10 years reported similar problems.
CONCLUSION: To cope with the risk of developing occupational disease, orthodontists should understand the nature, the mechanisms and the prevalence of the disorders they may acquire in their daily practice. The importance of preventive

measures such as respecting an adapted working posture, wearing appropriate gloves, masks and protective glasses or observing basic precautions in manipulating resins are emphasized.

184 FACIAL LANDMARK LOCALIZATION BY CURVATURE MAPS AND PROFILE ANALYSIS

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AIM: Landmarks on the face are crucial for orthodontic examination, harmony assessment and treatment planning. This study presents an objective method of measuring selected facial landmarks on the basis of analysis of curvature maps and of the sagittal profile.
MATERIALS AND METHOD: Faces were scanned in three-dimensions with a laser scanner, FastSCAN. Within one minute, a curvature map showing the distribution of gaussian and mean curvatures was displayed, allowing easy location of anatomical structures. The surface fitting and curvature calculation were performed at each surface point until the whole face was covered and the curvature map was drawn. The convex and concave areas of the face were 'painted' with different colours according to their Koenderink shape index. The faces of 15 subjects were scanned (10 females, 5 males; mean age 28.2 years, SD 5.5 years) and their curvature maps were calculated. From the Koenderink shape index maps, the landmarks in the midsagittal plane were located. Seven distances from the anatomical landmarks were calculated and compared with the clinical measurements of an experienced orthodontist. One of the 15 faces was scanned by the same researcher consecutively for three days to study the reproducibility of locating these anatomical landmarks and profile analysis.
RESULTS: The distances measured by the curvature maps were coincident with the manual measurements. Most of the errors were less than 1 mm and large ones within 2 mm. Most large errors were due to scanning problems. Agreement between the calculated and measured distances could be higher if the scanning quality of the face could be further improved. ANOVA ($P = 0.9992$) indicated that there were no significant differences among the three day measurements.
CONCLUSION: This pilot study can be taken as the first step to automatically locating the anatomical landmarks and calculating the desired distances for evaluation of facial characteristics.

185 IMAGES OF STUDY CASTS AS A MEANS TO ASSESS MALOCCLUSION AND TREATMENT NEED

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AIM: To compare the level of agreement between digital images and visual assessment of study casts in determining dental arch relationship and orthodontic treatment need.
MATERIALS AND METHOD: Digital images of 313 study casts were obtained employing a standardized approach. The dental arch relationship was assessed by the first permanent molar relationship (Angle's classification) and the size of the overjet and overbite. Orthodontic treatment need was determined using the Dental Health Component of the Index of Orthodontic Treatment Need (IOTN; Richmond *et al.*, 1992). Assessment of casts and digital images were conducted independently. Kappa (κ) analysis was used to evaluate agreement of categorization of orthodontic need and molar relationship, and correlation analysis [intraclass correlation coefficients (ICC)] to determine agreement for overjet and overbite.
RESULTS: A definite orthodontic treatment need (IOTN 4-5) was found in 41.8 per cent from the study casts and 38.3 per cent from the digital images, $\kappa = 0.79$. For molar classification for the two methods, the κ values were 0.77 and 0.79 for the right and left molars, respectively. The ICC for overjet and overbite were 0.94 and 0.96, respectively.
CONCLUSION: Digital images of study casts can be used as an alternative to visual inspection of the study casts in assessing dental arch relationship and orthodontic treatment need.

186 A THREE-DIMENSIONAL METHOD FOR THE KINEMATIC ANALYSIS OF THE HUMAN SMILE

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AIM: To detect kinematic features of lip changes that could differentiate natural and posed smiles.
SUBJECTS AND METHOD: Thirty healthy volunteer female subjects performed both types of smile, i.e. natural smile (5 trials) and posed smile (5 trials). A three-dimensional (3D) infrared motion capturing device (ProReflex Motion Capture Unit, Qualysis, Gothenburg, Sweden) was used to record motions of the lips during smiling for 5-10 seconds at a sampling frequency of 100 Hz. Four spherical markers were used as facial reference markers in order to minimize the effects of natural head movement on the recorded data, and four markers were employed to measure the motion of the lips during smiling. The four markers on the lips were located at the right corner of the mouth (CMR), the left corner of the mouth (CML), the upper lip on

the facial midline (ULM) and the lower lip on the facial midline (LLM). The targeted portion of the smiling action was defined as the 3D displacement from the start until the peak of the smile. The start and peak frames were quantitatively determined for each lip marker and for each type of smile. The duration of a smile for each lip measured marker was defined as the time course of the displacement from the start until the peak. Velocity in the three directions was obtained for each marker in each trial for both types of smiles. Mean durations and mean velocities of the 30 subjects were tested (Wilcoxon's signed rank) for differences between the natural and posed smiles, as well as between the markers CMR and CML, and ULM and LLM.
RESULTS: The natural smile showed a longer duration for both corners of the mouth and upper and lower lip midpoints than for the posed smile ($P < 0.001$). Differences in movement durations between CMR and CLR and between ULM and LLM were not determined. The mean velocities in the three directions were found to be faster in the posed smile ($P < 0.001$). Comparisons between right and left corners of the lips showed faster movement for the right corner in the lateral direction ($P < 0.000001$). In contrast, faster movement was determined for the left corner of the lip in the antero-posterior direction ($P < 0.001$).
CONCLUSION: The proposed 3D method detected subtle lip changes in the form of kinematic features differentiating the natural smile from the posed smile.

187 TREATMENT OF PATIENTS WITH SUBCONDYLAR FRACTURES USING THE SPRING ACTIVATOR

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AIM: The treatment of subcondylar fractures can be approached either conservatively or surgically. Conservative treatment is the most common approach taken by clinicians and includes rigid as well as semi-rigid immobilisation of the fracture and functional therapy. Functional treatment of subcondylar fractures using the spring activator has been cited in the literature. The elastic springs have been shown to have an effect on the neuromuscular activity of the muscles of mastication.
SUBJECTS AND METHOD: Thirty-five patients with subcondylar fractures of the temporomandibular joint seen between 1998 and 2001. A functional rehabilitative approach using the spring activator was taken for all patients. Evaluation of the efficiency of the appliance was made at clinical follow-up examinations by recording the mandibular mobility index, after Helkimo (maximum mouth opening, lateral and anterior mandibular excursions, opening and closing curves of the mandible and the occlusal relationship in maximum intercuspation). Additionally, the influence of the patient's age, time of appliance insertion after trauma, and patient compliance, on the success of functional therapy was documented.
RESULTS: The functional findings were different for each patient. On average however, a maximum mouth opening of >40 mm could be achieved. In most cases, treatment was accompanied by physiotherapy. A correlation was found between the efficiency of the spring activator and mandibular growth rotation.
CONCLUSIONS: Treatment with the spring activator leads to an improvement in mandibular position, as well as a definite enhancement in mobility. However, this only occurs provided the appliance is worn by the patient and examined by a clinician on a regular basis, so that the appliance springs can be activated every 4–6 weeks.

188 PROFILE ANALYSIS FOR APPRAISAL OF INTERMAXILLARY RELATIONSHIPS

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AIM: To determine whether classification into skeletal Classes I, II and III is possible by means of profile photographs.
MATERIALS AND METHOD: Using the Wits appraisal (Jacobson), a total of 180 patients were classified by means of radiographs into skeletal Classes I, II and III. Fifty eight were classified as Class I, 60 as Class II and 62 as Class III and their radiographs were available for the analysis. No differentiation of Class II into division 1 or 2 was carried out. The average age in Classes I and II was 13.6 years and in Class III 11.6 years. Defined angles and sections and the analysis of the soft part profiles at the corresponding profile lateral radiographs were recorded.
RESULTS: Photographic analysis of the various soft tissue profile angle with exit points on the forehead and subnasal area showed that the respective mean values were statistically significantly different between the skeletal Classes. Discrimination analysis resulted in the smallest error in the convexity angles N'SnPog' (75.8%), Gl'A'Pog' (85.5%) and TrA'Pog' (80.7%) for Class III malocclusions. For Class I the most uncertain classification for all angles was possible. The smallest inaccurate classifications were obtained for angles estimated at point A', angles TrSnPog' (45.6%) with TrA'Pog' (40.0%) and Gl'SnPog' (41.7%) with TrA'Pog' (38.9%). The method errors, according to Dahlberg's formula, showed relatively high values of 1.07 degrees for N'SnPog' to 1.71 degrees for N'A'Pog'.
CONCLUSION: The precise classification of patients into skeletal Class I, II or III only by means of the profile analysis of a lateral radiograph is not possible without doubts. Most accurately, the classification to Class III by the profile angle Gl'A'Pog' takes place.

189 EFFECTS OF LIGHT CURING PARAMETERS ON BOND STRENGTH OF A GLASS IONOMER CEMENT

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AIM: To investigate the influence of different light curing parameters on the shear bond strength (SBS) of a light curing glass ionomer cement (GIC).

MATERIALS AND METHOD: Two hundred and forty caries free extracted human teeth were allocated to 24 different groups (n = 10). After cutting off the roots and extirpating the coronal pulp, the crowns were embedded in polyurethane resin specimens measuring $30 \times 20 \times 12$ mm^3. Stainless steel lingual buttons were bonded to the labial tooth surfaces with resin reinforced GIC (Fuji Ortho LC). The adhesive was cured with a conventional halogen light curing unit (Heliomat, Vivadent) from four different sides (incisal, mesial, gingival, distal). The curing time was 5, 10 or 20 seconds. Different light guides were used resulting in light intensities of 310, 630, 800 and 1100 mW/cm^2 at a distance of 5 mm. The angle between the tooth surface and light guide was either 45 or 90 degrees. After polymerisation, the specimens were stored in tap water at room temperature for 30 minutes. The SBS of all lingual buttons was tested with a universal testing machine according to ISO standard 10477 and the results were statistically analyzed.

RESULTS: Light angle had a significant effect on SBS. Neither light curing time nor light intensity had a significant effect on the SBS. However, analysis of variance showed an interaction of light angle, intensity and curing time. Under the 45 degree angle, significantly higher SBS values were noted with a light intensity of 630, 800 and 1100 mW/cm^2 than with 310 mW/cm^2. On the other hand, with a 90 degree angle, neither light intensity nor light curing time had a significant influence on SBS.

190 TEMPOROMANDIBULAR JOINT DYSFUNCTION IN ORTHOGNATHIC PATIENTS

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AIMS: To establish the percentage of orthognathic patients with temporomandibular dysfunction (TMD) and to compare orthognathic patients with and without TMD, in terms of clinical findings and quality of life (QoL).

SUBJECTS AND METHOD: New patients over 16 years of age were recruited from a joint orthodontic/orthognathic surgery clinic over an 8 month period. The sample included 31 patients (21 females, 10 males) with a mean age of 24.06 years (SD 7.8 years). The study involved a non-invasive clinical examination to determine tenderness and pain in the temporomandibular joints and surrounding muscles, and also the range of motion, and a questionnaire to investigate QoL [Oral Health Impact Profile-14 (OHIP-14)]. The presence of TMD was classified according to the European Academy of Craniomandibular Disorders (EACD) based on the clinical findings. Repeatability tests were undertaken for the clinical examination and the EACD classification. In addition, a repeatability study was carried out to ensure intra-observer consistency for the palpation force used in the clinical examination. Statistical analysis was mainly descriptive but, for comparison of groups, also included the independent sample *t*-test and Mann-Whitney test for continuous data, and chi-squared and Fisher's exact tests for categorical data.

RESULTS: The percentage of orthognathic patients with TMD, as classified by the EACD, was 35.5 per cent. Within the TMD group, 72.7 per cent were female and 27.2 per cent were male, this confirmed the higher rate of female patients affected by this disorder. The results showed that there were minor differences in the clinical findings between the TMD and non-TMD groups. In addition, the results from the OHIP-14 showed that the TMD patients reported significantly poorer QoL ($P = 0.005$) than those without TMD.

CONCLUSIONS: Over one-third of the orthognathic patients in this study presented with TMD. Therefore, careful examination and assessment using a structured method for classification (i.e. EACD) and detailed history taking are essential. In addition, improved teaching with regard to the diagnosis and management of TMD is advocated.

191 TOWARDS AN UNDERSTANDING OF NON-SYNDROMIC OLIGODONTIA

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AIM: Hypodontia is the most common dental anomaly in man and affects different parts of the dentition with varying frequency. Hypodontia can present as an isolated sporadic condition or a familial trait, rarely in isolation, and more commonly in association with syndromes including orofacial clefting and ectodermal dysplasia. Commonly one or few teeth are missing while non-syndromic severe hypodontia is rare. Non-syndromic hypodontia has been linked to mutations in regulators of early tooth development, transcription factors Msx1 and Pax9, and more recently, Axin-2 regulating beta-catenin signalling. The aim of this study was to investigate the aetiology of non-syndromic oligodontia in three members of a family who presented with a unique pattern of severe hypodontia affecting molars (mainly) and premolars only, by analysing the MSX1 and PAX9 loci for mutations.

SUBJECTS AND METHOD: Two girls (13 missing teeth each) and their mother (11 missing teeth) had a distinctive loss of molars with no other phenotypic expression, whose patterns suggested a mechanism of haplo-insufficiency. Genomic DNA was isolated from whole blood samples using standard procedures. Primers were designed to amplify the exons and flanking regions of the two genes by polymerase chain reaction (PCR). PCR products were purified by ion exchange chromatography and sequenced using Thermosequenase Cy 5.0/5.5 kit (Amersham) and Open Gene System (Visible Genetics).
RESULTS: Substitution of C for G in nucleotide position 570 of MSX1 in both daughters, but sequence consistent with GenBank reference sequence in the mother, indicated that this nucleotide exchange was not inherited from the mother. Conservative nucleotide substitution of T for C in position 717 of PAX9 in the mother only was a previously described allelic variant that is not causative for the described condition.
CONCLUSIONS: A family in which the phenotype of oligodontia affecting molar teeth is not related to mutations in Msx1 or Pax9 has been identified. The phenotype is inconsistent with previously described Axin-2 mutations suggesting that a yet to be identified locus can cause isolated molar oligodontia.

192 A SURVEY OF PLAQUE ACIDOGENICITY IN CHILDREN WEARING FIXED ORTHODONTIC APPLIANCES

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AIM: The application of fixed orthodontic appliances presents a risk for plaque accumulation, decalcification and white spot caries formation in the dentitions of patients undergoing therapy. One of the unique aspects of caries development in orthodontic populations is the shift in plaque virulence and acidogenicity during therapy. The aim of this study was to examine the normalized acidogenicity potential of plaque from children undergoing orthodontic treatment with fixed appliances using a plaque glycolysis technique.
SUBJECTS AND METHOD: Sixty patients with fixed upper and lower appliances, who met all inclusion/exclusion criteria. Plaque was sampled from around facial brackets using a sterile cotton swab. Collected plaque was dispersed in Trypticas Soya Broth media and standardized to a constant optical density (0.2 abs at 600 nm) in a spectrophotometer. Plaque glycolysis was initiated by the addition of sucrose and plaque acidogenicity was assessed following 2 hours' incubation at 37°C in an Eppendorf thermomixer. Plaque acidity was recorded as the minimum pH following incubation using a standardized micro pH electrode.
RESULTS: Normalized plaque acidogenicity varied between orthodontic patients, with a 10-fold range in generated acid (pH ranging from 4.8–5.8 e.g. a 10 fold difference). The average pH generated in orthodontic patients measured 5.2 ± 0.28. This pH was lower than the standard pH assessed in adult populations (selected for acidogenicity) participating in plaque glycolysis screenings.
CONCLUSIONS: Plaque acidogenicity could be assessed in orthodontic patients using a simple standardized plaque glycolysis technique. The strong acidogenicity of plaque in orthodontic patients is consistent with microbial population shifts and caries risk in these children. Development of clinical correlates may permit the application of plaque glycolysis to patient risk assessment and also the evaluation of chemotherapeutic treatments.

193 EFFECTS OF THE DYNAMAX APPLIANCE ON NASO-OROPHARYNGEAL AIRWAY DIMENSIONS

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AIM: The Dynamax appliance is a treatment method for the correction of Skeletal II malocclusions with mandibular retrusion in growing patients, which has two main components: the upper appliance is removable, whereas the lower part can be either removable or fixed. Progressive mandibular advancement is the main advantage together with maxillary expansion, control of maxillary growth, as well as vertical facial development. The aim of this study was to evaluate the pharyngeal airway dimensions of subjects following treatment with a Dynamax appliance.
SUBJECTS AND METHOD: Twenty-six patients (mean age: 13.1 years) treated with a Dynamax appliance for correction of a skeletal Class II malocclusion. Seventeen Class I subjects (mean age 15.2 years) treated by fixed mechanics served as the control group. Pre- and post-treatment archival lateral cephalograms were used to compare the nasopharyngeal (NPA) and oropharyngeal airway (OPA) dimensions before and after orthodontic treatment. Linear and angular measurements were carried out using computer software, Pordios. The differences between the treatment and control groups were analysed using repeated measurement ANOVA and Duncan's tests.
RESULTS: NPA was statistically significant between the two groups ($P < 0.05$), but NPA before and after treatment was not statistically significant. OPA showed a statistically significant difference ($P < 0.05$) regarding treatment changes. Whilst

OPA increased following orthodontic treatment both in the control and treatment groups, the increase in the Dynamax group was larger when compared with the control group (8.9 to 10.1 mm).
CONCLUSION: The Dynamax appliance caused a slight increase in the oropharyngeal airway dimension, though it was statistically insignificant when compared with the control group.

194 EFFECT OF COMBINED ANTIMICROBIAL REGIMENS ON PLAQUE ACIDOGENICITY

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AIM: Plaque accumulation in patients with fixed orthodontic appliances increase the caries risk. Fluoride dentifrice alone may be inadequate to compensate for caries challenge. The aim of this research was to compare two antimicrobial dentifrice-mouth rinses on the acute response of dental plaque in acid formation *ex vivo*.
SUBJECTS AND METHOD: During the first visit a baseline plaque sample was taken. Thirty orthodontic patients with an initial pH <5.75 were assigned to one of three treatment regimens: I: Blend-a-Med® mineral action fluoride toothpaste and sterile water; II: Colgate® Total™ triclosan – fluoride antimicrobial dentifrice and Listerine® Cool Mint mouthrinse; or III: Crest® Pro Health stannous fluoride antimicrobial dentifrice and Crest® Pro Health mouthrinse. Treatment involved 40 seconds brushing with the test toothpaste followed by 30 seconds rinsing with the mouth rinse. Plaque samples were collected 15 and 45 minutes post-treatment and dispersed in TSB media and standardized to a constant optical density (0.2 abs at 600 nm). Plaque glycolysis was initiated by addition of sucrose and plaque acidogenicity (recorded as the minimum pH following incubation using a standardized micro pH electrode) was assessed after 2 hours of incubation. Plaque acidity was used to calculate treatment effects as a standard area under curve (AUC) analysis.
RESULTS: Baseline plaque acidogenicity was not significantly different in subjects assigned to treatment: I (5.10 ± 0.12), II (5.14 ± 0.16), III (5.27 ± 0.32) ($P = 0.19$, Student's *t*-test). Antimicrobial regimen treatments significantly inhibited plaque glycolysis response as compared with standard fluoride dentifrice and water, with acute treatment AUC effects measuring: I (9.5 ± 5.1), II (30.9 ± 14.7), III (45.8 ± 24.0) (statistical comparisons I versus II $P = 0.0011$; I versus III $P = 0.0009$; II versus III $P = 0.1144$ s).
CONCLUSIONS: Both antimicrobial paste-rinse combinations provided significant benefits in reducing plaque acute acidogenicity. The combination of Pro Health regimen appeared more effective in limiting acute plaque acidogenicity versus the other antibacterial treatments. Patients undergoing fixed orthodontic therapy may benefit from including antimicrobial paste and rinse regimens into their oral care routine.

195 VERTICAL BRACKET PLACEMENT ERRORS IN THE STRAIGHTWIRE SYSTEM

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AIM: To determine vertical bracket positioning errors during direct bonding when the mid point of the clinical crown is used as the bonding reference point as recommended in the straightwire system.
MATERIALS AND METHOD: The clinical crown height was measured on 35 study models of patients undergoing orthodontic treatment. The bracket positions of the same patients were then measured using a digital calliper. The intraoral measurements were made from the occlusal or incisal edges to the mid point of the vertical slot of the brackets. The figures obtained from the model and intraoral measurements were compared using a paired sample *t*-test.
RESULTS: There were statistically significant differences between the bracket positions and half of the clinical crowns of the upper left and right central, lower left and right premolars ($P \leq 001$), upper left canine and upper left premolar teeth ($P < 0.5$), i.e. the bracket positions of these teeth showed a significant deviation from the recommended measurements in the straightwire system. The closest relationship between bracket position and the mid point of the clinical crown was found for the upper left laterals and lower left second incisors ($P > 0.5$). Because of the shape of the central and lateral teeth and dimensional anomalies, bracket placement individualization is necessary. This could be the reason for the vertical errors for the upper central incisor teeth. During direct bonding viewing the premolar teeth from the correct perspective is difficult, so there could be positioning errors. For the left upper canine tooth, which is at the contralateral corner of the upper arch, for a right-handed clinician, the same reasoning may be accepted.
CONCLUSION: Ideal bracket positioning is necessary to obtain a good occlusion at the finishing stages in the straightwire system. However, vertical bracket positioning errors may occur especially on the premolar teeth. Therefore, when the mid point of the clinical crown height is used during direct bonding, bracket placement gauges should be used to eliminate the vertical positioning errors.

196 LONG-TERM PERIODONTAL STATUS OF PATIENTS WITH MANDIBULAR LINGUAL FIXED RETENTION

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AIM: To evaluate the periodontal tissues of patients with a mandibular fixed retention scheme for long or short periods of time.

SUBJECTS AND METHOD: Sixty-four individuals selected using the following inclusion criteria: long-term lingual fixed retention; identical type of lingual fixed retainer bonded with the same materials; no cavities, restorations or fractures of the mandibular anterior teeth; absence of habits and occlusal interferences; and canine guidance bilaterally. The resultant sample comprised 32 patients (mean age 25 years) who had been in retention for a mean period of 9.65 years (range 9-11 years) and an equal number retained for a period between 3-6 months. Plaque, gingival and calculus indices, probing pocket depth, marginal recession and bone level at the mandibular six anterior teeth were recorded for both populations. Demographic, clinical, and radiographic data were investigated with conventional descriptive statistics. Comparisons of the different variables between the two participant groups (long- and short-term retention) were conducted using the Mann-Whitney test for indices (plaque, gingival and calculus), and a Fisher's exact test (two-sided) for the remaining variables.

RESULTS: No significant differences were found with respect to the plaque and gingival indices and bone level between the two groups. The long-term retained subjects presented higher calculus accumulation, larger marginal recession, and increased probing depth.

CONCLUSIONS: The results of this study raise the question of appropriateness of the lingual fixed retainer as standard retention for all patients regardless of their attitude on dental hygiene. They also emphasize the importance of individual variability and cautious application of retention protocols after a thorough consideration of issues related to tissue anatomy and oral hygiene.

197 DEMINERALISATION EVALUATED BY MICROCOMPUTED TOMOGRAPHY, QUANTITATIVE LIGHT FLUORESCENCE, AND POLARISED LIGHT MICROSCOPY

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AIM: To evaluate the influence of five different materials for bonding orthodontic brackets on the amount of enamel demineralisation by comparing the quantitative parameters: lesion depth (Ld), mineral loss (ΔZ) and fluorescence loss (ΔF), which were collected by three different *in vivo* quantification methods [microcomputed tomography (μCT), quantative light fluorescence (QLF) and polarised light microscopy].

MATERIALS AND METHOD: The agents for enamel preparation and bonding were: Group 1, Transbond Plus SEP and Transbond XT; Group 2, 37 per cent phosphoric acid, ProSeal and Transbond XT; Group 3, Clearfil Protect Bond and Transbond XT; Group 4, 37 per cent phosphoric acid and Light Bond, and group 5, Ortho conditioner and Fuji Ortho LC. A total of 85 extracted teeth were randomly allocated to each group. Acid-resistant varnish was applied to each tooth by leaving a 1 mm rim of exposed sound enamel surrounding the bracket. *In vitro* caries was created by pH cycling for 30 days. A commercial polychromatic cone-beam microtomographic system (μCT 40) was used to scan the teeth after their demineralisation. QLF images were obtained after removal of the varnish. Finally the teeth were sectioned longitudinally by a microtome and examined with polarised light microscopy.

RESULTS: Statistical analysis showed that, for all quantification methods, there were significant differences within the five examined groups according to Ld, ΔZ and ΔF ($P = 0.001$). For the resin-modified glass ionomer cement, the quantitative evaluated parameters showed the lowest values. A good correlation for the three methods (μCT, QLF, polarised light microscopy) was found. In particular, ΔZ measured by μCT and ΔF with QLF evaluation showed the best correlation.

CONCLUSION: The resin-modified glass ionomer cement showed a significant Ld as well as a lower ΔZ and ΔF in comparison with the other materials. The commercial polychromatic cone-beam microtomographic system (μCT 40) seems to be suitable for the evaluation of subsurface lesions.

198 WHICH FACTORS AFFECT INFORMATION RETENTION IN ORTHODONTIC PATIENTS?

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AIM: To determine factors that affect retention of information provided in different formats.

SUBJECTS AND METHOD: Eighty new patients randomly allocated to one of two groups (40 in each group). The first group was given a leaflet about orthodontic treatment and the second group received a visual computer program

incorporating exactly the same information as the leaflet. Additional identical verbal information was given to both groups. A questionnaire was used to assess retention of information immediately after receiving the information, and subsequently longer term retention was assessed using the same questionnaire, mailed eight weeks later. Demographic data was recorded: age, gender, ethnicity and postcode (to generate Townsend scores as a proxy for material deprivation). The time taken to view/read the information provided was also recorded. Linear regression analysis was undertaken to assess the relationship between retention of information and the abovementioned variables mentioned.
RESULTS: The response rates for the first and second questionnaires were 100 and 67.5 per cent, respectively. The mode of information provision was found to be the only statistically significant factor affecting information retention, with the visual group achieving higher scores than the written group. Overall, with time, scores for both groups decreased by a negligible amount, but there was no evidence that with time, one group remembered less than the other.
CONCLUSIONS: Computer based visual information is a better method for information retention. Consequently, it is worth considering providing information to orthodontic patients in a more visual format if information is to be retained more effectively. Greater emphasis should be placed on retainer wear and oral hygiene procedures as these questions were poorly answered.

199 OUTCOME AND COST ANALYSIS OF ORTHODONTIC SERVICES IN FINNISH PUBLIC DENTAL CARE

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AIM: To compare the costs of orthodontic care of subjects with residual treatment need in eight Finnish health centres applying different treatment modalities.
SUBJECTS AND METHOD: A random sample from two age groups, 16- and 18-year-olds (n = 1109), in eight municipalities was examined by three specialist orthodontists. The subjects were assessed using the Dental Health Component (DHC) of the Index of Orthodontic Treatment Need (IOTN) for residual treatment need, and by the Occlusal Morphology and Function Index (OMFI) for the acceptability of occlusion. The history of orthodontic treatment was gathered by means of a questionnaire. The data concerning orthodontic treatment were afterwards collected from the records of all subjects with previous or ongoing orthodontic treatment (n = 608). Subjects with ongoing treatment and those treated outside the studied health centres were excluded, and thus 518 subjects were included in the study group.
RESULTS: Fifty-four per cent of the subjects had a history of orthodontic treatment, the average duration of which varied from 20 to 67 months in eight health centres. The variation among the health centres in the acceptability of occlusion using the OMFI was 14-42 per cent among the treated subjects (n = 518), and 26-60 per cent among those with no treatment history (n = 505). The variation among the health centres in residual treatment need measured by the DHC (Grades 4-5) was 3-30 per cent among the treated, and 13-26 per cent among the untreated subjects. Total average costs per treated individual varied between 517 and 926 euros. The share of appliance costs of the total costs varied between 13-32 per cent, according to the selection of appliances.
CONCLUSIONS: The almost 10-fold difference in residual treatment need among treated subjects, together with clear differences in the cost of treatment, highlights the need for improvements in the cost-effectiveness of orthodontic treatment.

200 DENTAL MATURATION OF CHILDREN WITH MELAS

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AIM: Mitochondrial encephalomyopathy, lactic acidosis and stroke-like episodes (MELAS) is a maternally inherited mitochondrial disease. It is most commonly caused by a 3243A>G mutation in mitochondrial DNA. The mutation leads to disturbed synthesis of the subunits of the respiratory chain and it is characterized biochemically by a decreased capacity to produce ATP in the cell. Clinically MELAS is characterized by considerable phenotypic variability and multiorgan involvement. It mostly manifests in organs with high aerobic energy metabolism, such as the nervous system, muscle and heart. The aim of this study was to determine whether dental maturation in children with MELAS differs from that in unaffected children.
SUBJECTS AND METHOD: Nine MELAS children (5 girls, 4 boys, mean age 12.0 years, range 7-15 years) born to mothers harbouring the 3243A>G mutation. The control group was an age- and gender-matched group of school children with normal dental development. Dental maturity was estimated from panoramic radiographs using the method of Demirjian based on the rating of development of seven left mandibular teeth. The dental maturity scores were converted directly into dental age using national standards for permanent tooth emergence in Finland. Different standards were used for boys and girls.

RESULTS: The MELAS children differed significantly from the controls in dental age ($P = 0.012$; Wilcoxon test). The dental age of MELAS children was 13.5 ± 2.6 years (mean ± SD) and that in the controls 11.4 ± 2.5 years. The dental age of the boys with MELAS was 1.5 years ahead of the controls, and the girls with MELAS were 2.6 years ahead of control girls in dental maturation. Dental age was also advanced when compared with chronological age both in controls and MELAS children.
CONCLUSIONS: It is suggested that the findings related to dental maturation are due to changes in endocrinological conditions. These results might also partly indicate that a mitochondrial mutation changes the control of the developmental pathway in an otherwise strictly genetically determined process. A mitochondrial mutation may predispose people to aberrant timing of dental development.

201 MICROHARDNESS OF AN ORTHODONTIC RESIN: EFFECT OF LIGHT SOURCE AND CURING METHOD

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AIM: To assess the effect of different light sources and curing methods on the microhardness of an orthodontic composite resin.
MATERIALS AND METHOD: A light-activated composite resin (Transbond XT, 3M Unitek) was polymerized under 120 metal orthodontic brackets. The resin/bracket specimens were pressed against the labial surface of a maxillary central incisor tooth that acted as a mould, and light-cured through human enamel. The brackets were randomly assigned to 12 experimental groups (n = 10). Each group of specimens was polymerized with a specific combination of light source [400 mW/cm^2 Ortholux XT (3M Unitek), 800 mW/cm^2 Ortholux LED (3M Unitek) and 1400 mW/cm^2 Bluephase 16i (Ivoclar Vivadent)] and curing method [5+5 seconds (mesial/distal), 5+5+5 seconds (mesial/ distal/occlusal), 10+10 seconds (mesial/ distal), and 10+10+10 seconds (mesial/distal/occlusal)]. Vicker's microhardness values (HV) were measured at the central area of the bracket with a Shimadzu microhardness tester. Data were analysed by two-way ANOVA followed by Student Newman Keuls multiple comparison of means ($P < 0.05$).
RESULTS: HV were significantly influenced both by the light source ($P < 0.001$) and the curing method ($P < 0.001$). Mean HV ranged between 1.1 to 32.3 for Ortholux XT, increasing to 24.7 to 46.0 for the Ortholux LED, and between 32.0 and 49.4 for Bluephase 16i. Increasing the time of light exposure resulted in higher HV, but the relationship was not linear. Mean HV were 1.1 to 32.0 (5+5 seconds), 12.3 to 41.8 (10+10 seconds), 22.2 to 45.3 (5+5+5 seconds), and 32.3 to 49.4 (10+10+10 seconds). A significant interaction ($P < 0.001$) was also found between the two main factors, with the curing method becoming less important with increasing light source intensity. The combination Bluephase 16i/10+10+10 seconds resulted in a significantly ($P < 0.05$) higher mean HV (49.4) in comparison with all the remaining groups.
CONCLUSIONS: 1) Increasing the light source power to 1400 mW/cm^2 significantly increased the composite resin HV for all curing methods. 2) Increasing light exposure time to 10+10+10 seconds (mesial/distal/occlusal) significantly increased the resin HV for all light sources. 3) The results suggest incomplete polymerization of the composite resin material in most experimental groups.

202 EVALUATION OF THE EISMANN, EISMANN-FARČNIK AND PEER ASSESSMENT RATING INDICES

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AIM: To compare the validity, reliability and the time required for use of the Eismann, Eismann-Farčnik (EF) and Peer Assessment Rating (PAR) indices.
MATERIALS AND METHOD: One hundred pre-treatment study casts from patients in the permanent dentition period (mean age 15.4 years, SD = 0.4 years; 53 females, 47 males). Three examiners trained and calibrated in the use of the Eismann, EF and PAR indices scored the casts using all three indices. A panel of 10 orthodontists individually rated the same casts for their degree of malocclusion severity. The mean rating of the panel on the severity of malocclusion was used as the 'gold' standard for evaluating validity of the three indices. Agreement for the three indices in assessing the severity of malocclusion was also evaluated. Ten randomly selected casts were then re-evaluated to determine reliability. Each evaluation was timed and rounded off to the nearest half minute.
RESULTS: Intraclass correlation coefficient (ICC) indicated almost perfect agreement for the EF index with the decisions of the panel of orthodontists (0.80), excellent agreement for the Eismann index (0.70) and the PAR index (0.73) with the specialists' opinion. Receiver operating characteristic curves were plotted for the three indices. The diagnostic accuracy, as determined by the area under the curve, was found to be highest for the EF index followed by the PAR and Eismann indices. Intra- and inter-examiner reliability was high (ICC >0.75) for all three indices. The most time consuming methods

were the EF (27.10 minutes) and Eismann (26.86 minutes) indices, while the PAR index (2.60 minutes) was the least time consuming.
CONCLUSIONS: Although all three indices are valid and reliable methods for assessing malocclusion severity and even though the EF index is the most time-consuming method, it was found to be the most useful for diagnosis in everyday clinical orthodontic practice.

203 CEPHALOMETRIC CRANIAL BASE FEATURES IN SKELETAL CLASS III PATIENTS
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AIM: The cranial base is a central anatomical structure connected to both the maxilla and the mandible and, hence, assumed to play an important role in Class III morphogenesis. The aim of this controlled study was to investigate cephalometric parameters of the cranial base in skeletal Class III patients to clarify the conflicting findings reported in literature.
MATERIALS AND METHOD: Initial lateral cephalometric radiographs of 54 skeletal Class III patients and 54 matched controls (Class I, Class II division 1 and Class II division 2) aged 14 to 24 years (mean ±SD 17.7 ± 3.1 years) were analysed retrospectively for 21 basicranial linear and angular variables and maxillary/mandibular length relative to anterior cranial base length.
RESULTS: Anterior (S-N) and posterior (S-Ba, S-Ar) cranial base lengths were not significantly reduced in skeletal Class III patients. The significantly more acute angles, Ca-S-Ba and Se-S-Ba, reflected, among others, the increased cranial base flexure in skeletal Class III. Resulting anterior condylar displacement was shown by significant reduction of Se-S-Cd and Ar-Ca. Minor changes were observed in various cranial base segments. Relative mandibular length was significantly increased in skeletal Class III patients, while relative maxillary length was not significant.
CONCLUSIONS: The decreased angulation of the cranial base associated with mandibular protrusion frequently reported in Class III anomalies was clearly confirmed, while no overall reduction of anterior and posterior cranial base lengths was found. Rather, the results indicate a complex individual interplay of morphological structures. They are compatible with the 'deficient orthocephalisation' hypothesis of Class III morphogenesis. The basicranial-maxillary relationship in skeletal Class III remains unclear. Future morphological studies should consider the heterogeneity of skeletal Class III patterns and focus on clinical and/or statistical subtypes in order to produce insights relevant to the identification of candidate genes for the anomaly.

204 ORTHOPAEDIC CORRECTION OF SKELETAL CLASS II ADULT PATIENTS
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AIM: To determine the skeletal, dental and soft tissue profile changes and the mechanism of Class II correction in a sample of mature individuals treated with the Herbst appliance.
SUBJECTS AND METHOD: A prospective study of 15 consecutive (4 males, 11 females) mature individuals treated with the Herbst appliance followed by multibracket appliance therapy was conducted. All subjects had a hand-wrist stage of R-IJ or R-J. Their mean pre-treatment age was 22 years (16.6-39.3 years). A stepwise advancement protocol was used. Lateral cephalograms from before treatment and at the end of multibracket appliance therapy were examined using standard angular cephalometrics and the linear SO analysis of Pancherz.
RESULTS: All patients were treated to an ideal Class I occlusion with normal overjet and overbite. The angular mandibular variables, SNB and SNPg, increased by 1.1 and 0.84 degrees, respectively. ANB reduction was 1.29 degrees. Soft tissue profile convexity, excluding the nose, reduced by 2.90 degrees, while profile convexity, including the nose, reduced by 1.43 degrees. The hard tissue convexity variable, NAPg, increased by 3.21 degrees. The correction of a Class II malocclusion involved skeletal and dental changes. Twenty-two per cent of the overjet correction was skeletal and 78 per cent dental. Twenty-six per cent of the molar relationship correction was skeletal and 74 per cent dental.
CONCLUSION: The Herbst appliance is an effective method for correcting a skeletal Class II malocclusion in mature non-growing individuals. It provides a non-surgical modality of treatment that avoids the deleterious effects of camouflage therapy by directly addressing mandibular retrognathism and improving facial convexity.

205 MATERIAL CHARACTERISTICS OF CURRENT SUPERELASTIC NICKEL TITANIUM WIRES
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AIM: The design and development of orthodontic nickel titanium (NiTi) wires is characterised by consistent market launches of new products with modified material properties. As a consequence the clinician is confronted with the problem

of assessing the clinically generated force systems correctly. It was the aim of this study to compare the material properties of a larger number of NiTi levelling arches. Conventional levelling archwires served as a reference.
MATERIALS AND METHOD: A total of 25 different superelastic NiTi wires were investigated: Advanced Orthodontics (NeoMemory27, Memory Twistflex), Dentaurum (Tensic, Rematitan Lite), Forestadent (Biostarter, Titanol Superelastic, Titanol Martensitic), GAC (BioForce, Sentalloy, NeoSentalloy), Masel (Elastinol, Therm-A-Form Ultra, CV Brand of NiTi 35°), ODS (EuroNiTi medium, OptoTherm), Ormco (Align XF, NiTi Turbo Arch, CuNi-Ti 27°C and 35°C), Smile Dental (Thermalloy, nickel-titan straightwires), Strite Ind. (Speed Supercable), 3M Unitek (Nitinol Classic, Nitinol super elastic, heat-activated). Nine conventional wires were investigated for reference: Dentaurum (Dentaflex, twisted 3- and 6-times, Noninium, twisted 3-times, Remanium, Noninium, all stainless steel, and Rematitan Special, titanium molybdenum), Smile Dental steel (twisted 7-times). The wire dimension 0.35 mm (round, 0.014 inch) was tested, if available. Otherwise the next higher dimension was used. The following measurements were performed at 37°C: three point bending test with a 10 mm span according to the ISO standard, biomechanical simulation using the Orthodontic Measurement and Simulation System, pure bending test, and determination of transformation temperature, Af, employing the 'bend and free recovery' method.
RESULTS: Both the three point bending test and biomechanical simulation revealed significant differences in the generated force systems, characterised by the height of the unloading plateaus (0.3 to 4.5 N), the endpoint (0.2 to 0.9 mm) and the slope of the plateaus (0.2 to 2.1 N/mm). Furthermore, the materials science investigations of pure bending and transformation temperature showed significant differences (Af temperatures between 10 and 36°C). Due to excessive force generation of up to 6 N, the plateaus of several wires were out of clinical range.
CONCLUSIONS: Despite similar alloy composition, the material properties of NiTi wires still differ significantly.

206 STRIPPING IN THE LOWER ARCH: IS IT AN EVIDENCE-BASED THERAPEUTIC DECISION?
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AIM: Enamel stripping is described in the literature as a clinical procedure widely used in orthodontics. The aim of this study was to evaluate if stripping is an evidence-based treatment to solve lower anterior segment crowding in adult patients.
MATERIALS AND METHOD: A systematic review of the literature on stripping was undertaken starting from the observation of a 19.3 year old patient with a skeletal and dental Class I malocclusion with a normal vertical jaw relationship, overjet of 2.5 mm, overbite of 3.5 mm, crowding of 4 mm in the lower arch, no crowding in the upper arch, IMPA 95 degrees, anterior Bolton index 78.5 and Peck index 94 (3.1-4.1) 97(3.2-4.2), to evaluate the effects of this technique to solve crowding of the lower anterior segment in terms of long-term stability, control of vertical dimension, aesthetics and periodontal health. The search was undertaking using the PubMed database and manually. The same criteria were used to assess each article using the EBM evaluation parameters.
RESULTS: Forty articles were found in the literature of which four were eligible. Indications for stripping were the same in all the articles: adult patient, permanent dentition, molar and canine Class I relationship, moderate crowding, Bolton index and normal overjet and overbite. Two articles showed that stripping could increase stability because the original arch form was respected; there was no increase of intercanine diameter and lower incisors axis, and the overbite was stable. One article showed no problems regarding periodontal health without a clinical demonstration; in another there was no pathological periodontal probing and a periapical radiograph without a Rinn device did not show a reduction of interradicular bone. There were no articles concerning aesthetics. None of these articles considered all the searched parameters together.
CONCLUSION: The query of the research was not satisfied.

207 COMPARISON OF SIMULATED HEADGEAR TREATMENT IN A PIG MODEL
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AIM: The biomechanical behaviour of the first molar with different eruption stages of the second and third molars has a crucial influence on the execution of headgear treatment of Class II patients. It was the aim of the study to analyse the mobility of multi-rooted teeth in an animal model and to experimentally and theoretically determine the influence of the tightness of the contact to the neighbouring teeth.
MATERIALS AND METHOD: The biomechanical set-up, Hexapod Measurement System, was used for experimentation. The second and third premolars of fresh pig jaw segments were chosen, as these are equivalent to the human molars, M1 and M2. The premolars were selected with five different stages of eruption. After measurement of the force/deflection characteristics with forces up to 15 N, three-dimensional surface models were reconstructed from histological cuts or computed tomographic scans with a self-developed program, ADOR3D. The reconstruction of the jaw segments into a finite element (FE) surface

model consisted of the second and third premolars, periodontal ligament (PDL), bone, the molar tube on M1, and headgear application. Subsequently, theoretical load/deflection curves were fitted to the experimental behaviour by varying the material parameter of the PDL, in order to determine the mechanical properties of the PDL. The material parameters of tooth and bone were taken from earlier experimental and numerical studies (tooth: E = 20 GPa, bone: E = 2 GPa). The calculations were performed with the FE package, MSC.Marc/Mentat. The results were compared with data from a clinical study.
RESULTS: The experimental results confirmed the clinical experience that distal translation of the first molar after headgear force application was highest if the second molar was present as a germ or only half erupted. In cases with a non-erupted second molar, the displacements of the first molar were 30 per cent higher. Maximum displacements reached values of up to 0.25 mm; maximum distal rotation was up to 1.5 degrees. With respect to the displacements, the FE results were in good accord with the experimental results. Maximum strains in the PDL reached approximately 0.1, stresses in the PDL were about 0.13 MPa, and in the bone 0.01 MPa.
CONCLUSIONS: The results of the pig experiments correlated well with clinical experience. With the force systems applied, the tooth socket seems to be loaded above the physiologic limit.

This study was supported by German Israel Foundation (GIF, 01910911).

208 EFFECTS OF BRACKET TYPE, BRACKET CONDITIONING AND THERMAL AGEING ON BOND STRENGTH

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AIMS: Bracket type, conditioning methods used for the enamel and the bracket base, and age of the bonded interfaces are factors that may affect bracket bond strength and eventually the failure type in orthodontics. The objectives of this study were to compare the shear bond strength of ceramic (Clarity™, 3M, Monrovia, California, USA) and metal (MBT, 3M Unitek) brackets to enamel surfaces with and without silica coating and silanization in either dry or thermocycled conditions, and to evaluate the failure modes after debonding.
MATERIALS AND METHOD: As received and conditioned ceramic and metal maxillary premolar brackets using silica coating and silanization (0.030 mm SiOx, CoJet Sand, 3M Espe) (n = 80, 10 per group) were bonded to newly extracted maxillary first premolars using Transbond adhesive under light polymerization (600 mw/cm^2) from four directions for 20 seconds. Bonding procedures were accomplished under a 700 g load in order to achieve an even film thickness of the adhesive resin. The specimens were either kept in water after bonding at room temperature for 1 week or thermocycled 1000 times (5-55ºC, dwell time 30 seconds). All specimens were tested in a universal testing machine (crosshead speed: 1 mm/minute) and thereafter examined under ×10 magnification to determine the failure mode according to Adhesive Remnant Index (ARI).
RESULTS: Conditioning the bracket bases significantly increased bond strength for both metal and ceramic brackets (15.67 to 18.71 and 9.47 to 16.95 MPa, respectively) (P = 0.0071; ANOVA, Tukey's test). Bracket type (P = 0.6580) and ageing (P = 0.4717) did not significantly affect the bond strength results. Failure types (ARI scores) were significantly different between the groups (P = 0.0000) (Kruskal-Wallis). Without ageing, both metal (3 out of 10) and ceramic brackets (8 out of 10) showed enamel fractures, but after thermocycling, while metal brackets showed only one fracture, three ceramic brackets showed enamel damage.
CONCLUSIONS: When additional adhesion is required, bracket base conditioning could be advised, however possible enamel damage should also be considered.

209 RESULTS AFTER TOOTH TRANSPLANTATION IN PATIENTS WITH MULTIPLE APLASIA

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AIM: To determine if tooth transplantation offers a viable treatment option in patients with multiple aplasia of permanent teeth.
SUBJECTS AND METHOD: Eleven patients (6 females, 5 males) with multiple aplasia in whom a total of 16 immature third molars had been transplanted during orthodontic treatment. Twelve transplants replaced first or second premolars in the upper or lower jaw, and four replaced lower first molars. The mean age at the time of transplantation was 16.8 years (15.9-18.2 years). Routine follow-ups, including clinical and radiographic evaluation of pulpal and periodontal conditions, were performed after 1, 3, 6, 9 and 12 months. After the first year, re-examination took place annually until the final follow-up.
RESULTS: The average follow-up period was 3.8 years (1.8-6.8 years). During the final follow-up, a positive reaction to sensitivity testing was observed for all 16 transplants. In addition, all transplants showed a regular periodontal condition with adequate root development.

CONCLUSIONS: Transplantation of immature third molars represents a promising and safe therapeutic concept, even in patients with multiple aplasia.

210 EFFECT OF TENSILE FORCE ON THE EXPRESSION OF PTHrP IN MOUSE SYNCHONDROSIS

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AIM: To evaluate the level and temporal pattern of the expression of PTHrP, a key factor known to regulate the rate of maturation of chondrocytes, in mouse spheno-occipital synchondroses in response to tensile force.
MATERIALS AND METHOD: The spheno-occipital synchondroses together with the adjacent structures were aseptically excised from 50 two-day-old BALB/c mice randomly divided into five control and five experimental groups (5 mice per groups). In the experimental group, a tensile force of 0.2 g was applied by helical springs across the spheno-occipital synchondroses; whereas in the control group, helical springs with no tension were used. Both groups were then cultured in serum-free BGJb medium for 6 hours and 1, 2, 3 and 7 days. The tissue were then fixed and 5 μm sections were cut; five sections from each mouse were used for identifying PTHrP level by immunohistochemical staining (n = 25) and measured with a computer-assisted image analyzing system by one operator. The difference in the level of expression was then analysed by *t*-test and one-way ANOVA.
RESULTS: PTHrP expression in both the control and experimental groups increased at 24 hour after force application, then reduced at 48 hours and continued to reduce until the last day of the experiment. However, the change in the control group was not significantly different at any time point, while the increase at 24 hours in the experimental group was statistically significant ($P < 0.05$) as well as its decease at 48 hours ($P < 0.01$) which interestingly made its level significantly lower than that of the control group ($P < 0.01$).
CONCLUSION: Condrocytes in organ-cultured mouse spheno-occipital synchondrosis significantly express more PTHrP in response to tensile force at 24 hours.

211 INFLUENCE OF CONDYLAR HYPERMOBILITY ON RELAPSE AFTER BITE JUMPING

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AIM: To examine the relationship between temporomandibular joint conditions and the variability and stability of bite jumping outcomes.
SUBJECTS AND METHOD: One hundred and fourteen patients (46 males, 68 females) aged 11-16 years with condylar hypermobility/subluxation assessed by manual functional analysis. All patients showed a skeletal Class II division 1 anomaly with an overbite of 6-8 mm. They were treated with a removable functional appliances (bionator), which they were instructed to wear 14 hours a day. The same conditions applied to the control group (120 patients; 42 males, 68 females), except for condylar hypermobility.
RESULTS: Treatment duration required to achieve a Class I relationship was 6.5 ± 1.5 month longer in 86 per cent of the females and 82 per cent of the male patients with condylar hypermobility compared with the control group. In 28 per cent of females and 22 per cent of males, a relapse of 2.8 ± 0.3 mm was detected 6 months out of retention.
CONCLUSION: Weak or lax capsules/ligaments associated with condylar hypermobility are unable to build up sufficient tension to stimulate larger bone remodelling. Hence, a longer treatment time, larger overcorrection, and longer retention are required. In some cases, fixed functional appliances, dentoalveolar compensation using mini-implants, or even extraction of the upper premolars is necessary.

212 ASSESSING QUALITY OF LIFE IN 4 TO 7 YEAR OLD PATIENTS WITH CLEFT LIP AND PALATE

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AIM: The assessment of health-related quality of life (HRQoL) of children with cleft lip and palate (CLP) is increasingly considered a relevant outcome measure in evaluating provided health care. The aim of this study was to examine the psychosocial functioning of 4 to 7 year old children with non-syndromic CLP attending the multidisciplinary CLP centre, and to compare the results with a group of previously examined healthy children.
MATERIALS AND METHOD: HRQoL was assessed with the revised German KINDL QoL questionnaire. The KINDL is a generic psychometrically based QoL measure for children, which has gained widespread use in Germany. This instrument consists of a 5-point 46-Likert-item questionnaire, distributed in six subscales, which correspond to six domains (physical well-being, emotional well-being, self-esteem, family life, friends and school). The total score is the sum of all item

scores. Higher scores indicate a better QoL. All parents of 4 to 7 year old children with non-syndromic CLP attending the multidisciplinary CLP centre were invited to take part in the study.
RESULTS: A total of 74 families were contacted and 61 of them participated (82% response). The 61 children (32 boys, 29 girls) had a mean age of 5.39 years. Confirmatory testing of the internal consistency showed that all of the subscales reached an α coefficient between 0.56 and 0.82; Cronbach's α for the total scale was 0.9. In general, the α coefficients for the CLP children were slightly lower than for the reference group of healthy children. Mean values, standard deviation (SD), minimum and maximum scores for the total scale and all subscales were computed. Comparison of the mean values for the total scale between CLP and healthy children demonstrated no statistically significant difference in QoL levels. The mean score for boys was 77.22 (SD 7.59) and for girls 78.37 (SD 9.54). The *P*-values equalled 0.73 and 0.36, respectively.
CONCLUSIONS: The evidence from this study demonstrates that 4 to 7 year old children with CLP do not appear to experience major psychosocial problems. However, professionals should continue to intercede to prevent or interrupt negative psychosocial outcomes in children with CLP as part of a multidisciplinary approach. Further research is desirable in order to acquire a more comprehensive database on HRQoL of children with CLP.

213 THE CARIES-PROTECTIVE EFFECT OF SEALANTS DURING ORTHODONTIC TREATMENT

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AIM: Enamel demineralization and the development of white spot lesions are undesirable side-effects of orthodontic treatment with fixed appliances. Therefore the sealing of the bracket surrounding areas is a frequently advocated procedure to avoid the development of caries. The aim of the present *in vitro* study was to investigate the efficacy of sealant and/or fluoride applications to prevent demineralization.
MATERIALS AND METHOD: Forty-nine extracted human caries-free teeth divided into seven equal groups, allocated to one of the following products: 1. Pro Seal (Reliance); Protecto F (BonaDent; 3. Enlight Fluorobond XM (Ormco); 3. Ortho Solo (Ormco); 5. Elmex gelée (Gaba), 6. Elmex gelée placebo (Gaba); and 7. titanium tetrafluoride (Sigma-Aldrich). On every buccal surface a premolar bracket (Mini Uni-Twin, APC™ II, 3M Unitek) was bonded. The group specific product was applied on the right buccal side of the enamel surface of each specimen (after etching the surface of groups 1, 3, 4 with 35% phosphoric acid). The untreated left side served as the control. The samples were positioned in a reaction-chamber under aseptic conditions on a spinning wheel. The chamber was then inoculated with *streptococcus mutans* (ATCC 25175) and the buccal surfaces were periodically rinsed with a saccharose-solution, a trypticase-soya-broth, and artificial saliva. Finally the samples were analyzed with a confocal laser scanning microscope (Seemann, 2005).
RESULTS: Whilst all teeth have not yet been completely investigated microscopically, qualitatively the findings were obvious. There was hardly any demineralization in the Pro Seal group. In the Enlight Fluorobond XM group the treated surfaces showed approximately a 40 per cent less lesion depth. Titanium tetraflouride also had a protective effect, while the effect of Protecto was much less. Surfaces treated with fluoride gel revealed about 20 per cent less demineralization. The lesion depth in the placebo group showed no difference between the two sides. In the Ortho Solo group, the demineralization was somewhat greater on the treated side.
CONCLUSIONS: Pro Seal produced the best result. However, it is important to mention that no abrasion that may occur *in vivo* through brushing and chewing was simulated.

214 COMPARISON OF MANUAL AND COMPUTER AIDED TOOTH SIZE MEASUREMENTS

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AIM: SureSmile is a CAD/CAM system that uses an intraoral orthodontic scanning device and three-dimensional diagnostics for treatment with customized fixed appliances. Exact measurement of tooth size is a prerequisite for treatment planning in conventional and computer aided orthodontics. The objective of this study was to compare different methods of tooth size measurements: standard plaster models analysed with callipers (the current 'gold' standard for cast assessment) and digital models measured with the SureSmile system.
MATERIALS AND METHOD: The dental casts of 16 patients were scanned with the OraScanner. Tooth-size was measured manually on the plaster casts with a digital calliper to the nearest 0.1 mm (gold standard) and digitally using the SureSmile software. Differences between virtual and manual measurements were calculated and a paired samples *t*-test was used to compare reliability and validity of measurements between the plaster and digital models. The influence of various factors on precision was estimated.

RESULTS: For 357 teeth, the average difference between manual and digital measurements was 0.15 ± 0.15 mm (range: 0.0-1.0 mm). No statistically significant difference was found between the groups. Reproducibility of digital models was excellent in most cases and good in some. There was a trend towards more exact measurement of the anterior teeth. The number of accessible approximal surfaces correlated with lower differences between measurements.
CONCLUSIONS: Digital and manual measurement of tooth size is similarly subject to inaccuracy. There are still problems in determining tooth size, especially in severely crowded cases. For routine measurements, SureSmile-based digital models are a clinically acceptable replacement for dental casts.

215 PAIN PERCEPTION WITH SELF-LIGATING AND CONVENTIONAL PRE-ADJUSTED EDGEWISE BRACKETS

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AIM: To investigate differences in the degree of pain and discomfort experienced during the period of initial orthodontic tooth movement using Damon3™ (Ormco) self-ligating and Synthesis™ (Ormco) conventional pre-adjusted bracket systems.
SUBJECTS AND METHOD: Sixty-two subjects (32 males, 30 females; mean age 16 years 3 months) with lower incisor irregularity of between 5-12 mm and a prescribed extraction pattern of four first premolar teeth were randomly allocated for treatment with either bracket system. Fully ligated Damon 0.014 inch copper NiTi archwires were used for initial alignment in both groups. Following archwire insertion, the subjects were given a prepared questionnaire to complete over the first week, recording discomfort by means of a 100 mm visual analogue scale (VAS) at 4 and 24 hours, 3 days and 1 week, using the terms 'very comfortable' and 'very uncomfortable' as weightings. Each VAS score was measured twice by the same operator, with the mean taken as the representative value, giving a quantitative score for each time frame. The subject also noted any analgesics and dosage taken during the period of observation.
RESULTS: A total of 60 questionnaires were returned, giving a response rate of 96 per cent. Analysis of variance (ANOVA) showed that there were no significant differences in perceived pain levels between the two appliances or for gender and age at any time point. However, mean pain score as a function of time showed the Synthesis group to exhibit a slightly lower level of perceived discomfort than Damon3, although this was not statistically significant. Self-prescribed analgesics were used by 60.6 per cent of the Damon3 group in comparison with 40.7 per cent of the Synthesis group.
CONCLUSIONS: Overall, this investigation found no evidence to suggest that Damon3 self-ligating brackets are more comfortable than conventional pre-adjusted brackets during initial tooth alignment. Amongst the two groups, a greater proportion of the Damon3 subjects sought analgesia during the first week of treatment.

216 NICKEL-TITANIUM LEVELLING WIRES IN LINGUAL APPLICATION – WHAT ARE THE FORCES?

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AIM: It is the aim of orthodontists to keep the forces of appliances within safe limits while at the same time achieving efficient tooth movement. In lingual orthodontics the small inter-bracket distances and the difficulties of clinically individualized archwires provide increased demands in archwire materials that generate reliable and safe force levels. In addition clinicians often feel the need to control torque early during treatment, which requires wires with large rectangular cross-sections. The large cross-section might influence the force level.
MATERIALS AND METHOD: Sixteen commercially available nickel-titanium (NiTi) levelling wires marketed by five companies for lingual treatment or commonly used for lingual treatment were tested. Ten specimens of each test wire were tested according to ISO 15841 in a three-point bending test in 35°C water.
RESULTS: In these NiTi wires the generated forces were mainly independent of the dimension. While a 0.016 inch GAC Sentalloy light wire had a superelastic plateau of around 40 cN, for the thinner 0.013 inch Ormco Copper NiTi it was around 70 cN, and for the 0.012 inch G&H wire 80 cN. High forces were especially present in rectangular archwires. As an example, the often used 0.016 × 0.022 inch Copper NiTi 35° showed initial forces of 500 cN and even on the plateau the forces were still above 180 cN. The initial force peak especially in rectangular wires appears to be the greatest problem in the use of NiTi levelling wires in lingual orthodontics.
CONCLUSIONS: It is absolutely necessary to know the measured forces of the wires used in lingual treatment. The dimension and marketing information are not indicative of the generated forces. It seems advisable to use a high-quality round wire in the initial phases of treatment.

217 GAS1 IS A POTENTIAL MODIFIER GENE FOR HOLOPROSENCEPHALY

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Holoprosencephaly (HPE) is a clinically heterogeneous and complex developmental field defect of the central nervous system, in which the embryonic forebrain or prosencephalon fails to divide into distinct halves. The underlying brain malformation can have a profound affect upon midline development of the face. In the most severe form, which is one of the commonest causes of miscarriage in humans, the forebrain remains as a single undivided vesicle and the face is characterised by cyclopia, with a single midline eye situated below a rudimentary nose or proboscis, and midline clefting of the lip and palate. However, a range of severity exists in both the brain malformation and craniofacial features that are seen, even amongst members of the same pedigree. In microform HPE, milder craniofacial features such as ocular hypotelorism, pre-maxillary agenesis and solitary median maxillary central incisor can occur in the absence of defects within the central nervous system. The aetiology of HPE is complex, with both genetic and environmental factors being implicated. A number of chromosomal regions and candidate genes have been identified for HPE, including Sonic hedgehog (SHH), ZIC2, SIX3 and TGIF; whilst environmental factors, such as maternal diabetes, alcohol or drug ingestion and defects in cholesterol metabolism have also been implicated in the aetiology of this condition.

Mutation in the Shh gene is a cause of HPE in both mice and humans. Gas1 encodes a GPI-linked membrane glycoprotein previously demonstrated to have an antagonistic effect on Shh signalling in the somite. The craniofacial phenotype of mice with targeted deletion of Gas1 have been analysed and it was found that they demonstrate microform HPE. There is mid-face hypoplasia, fusion of the maxillary incisors and cleft palate; however, gross structural integrity of the forebrain remained intact. Surprisingly, these defects are associated with a partial loss of Shh transduction in cells at a distance from the source of transcription; suggesting that Gas1 can potentiate long-range hedgehog signalling in the early face. Indeed, loss of a single Shh allele in a Gas1 mutant background significantly worsened the midline craniofacial phenotype, providing evidence that Shh and Gas1 function in the same pathway. The results establish Gas1 as a potential modifying locus for HPE in human populations.

Funded by a European Union Marie Curie Early Stage Fellowship.

218 THE EFFECT OF HEADGEAR TREATMENT ON ASYMMETRY IN THE CANINE ERUPTION PATTERN

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AIM: To compare left-right differences in the inclination of permanent maxillary canines after early headgear treatment.

SUBJECTS AND METHOD: Sixty-eight children (40 boys, 28 girls) aged 7.6 years (standard deviation 0.3 years). The children who had a Class II tendency in occlusion were randomly divided into two equal groups. Headgear treatment was initiated immediately in the first group, while in the second group only minor interceptive procedures were performed during the first follow-up period of two years. Dental pantomograms were taken four times with a one year interval, and after growth at 16 years of age. The angle between the axis of the upper canines and the dental midline, and the angle between the axis of the canines and the axis of the lateral incisors were measured bilaterally.

RESULTS: There was a significant difference between the headgear and control group in asymmetry of the inclination of the maxillary canine to the midline at the one and two year follow-up ($P < 0.02$). The canine was in a more vertical position on the right side in the headgear group at the follow-up. The canine angulation in relation to the lateral incisor was also smaller on the right side in the headgear group. The difference was significant two and three years after the initiation of headgear therapy ($P < 0.03$).

CONCLUSION: Early headgear treatment has a significant influence on the eruption pattern of maxillary canines. However, the influence seems to be more marked on the right side, causing asymmetry in the eruption pattern.

219 THE EFFECT OF EXTRACTION AND NON-EXTRACTION ORTHODONTIC TREATMENT ON SMILE AESTHETICS

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AIMS: To test the hypothesis that non-extraction and premolar extraction Caucasian female smile photographs are scored equally, and to assess if there is a difference in the arch widths of these two groups.

SUBJECTS AND METHOD: Ten young Caucasian females treated to a standard suitable for the postgraduate examinations (5 non-extraction, 5 extraction). Frontal smile colour photographs and dental impressions were taken of the subjects. The

smile photographs were evaluated by 100 assessors comprising equal numbers of male and female orthodontists and male and female lay people. The assessors were also asked to record the factor that most influenced the scores awarded to the photographs. Dental casts were measured for arch width using digital callipers. Statistical analysis was completed with an ANOVA test for smile photograph scores and a Mann-Whitney *U* test for comparison of cast measurements.
RESULTS: Non-extraction smiles were scored more favourably than extraction smiles by both orthodontists ($P < 0.01$) and lay people ($P = 0.03$). This difference was attributed to lip position, tooth colour and tooth shape. There was no difference between male and female scores. The non-extraction group had greater maxillary ($P = 0.03$) and mandibular ($P = 0.02$) interpremolar distances compared with the extraction group, but the intercanine and intermolar widths showed no statistical difference. While previous investigations have shown there to be no difference between non-extraction and extraction smile scores awarded by lay people and orthodontists, this study showed the contrary. Whether this difference is due to buccal corridor space or not remains unclear. Only one assessor out of 100 found this to be a deciding factor in the scores awarded. This highlights that other factors such as lip position, tooth alignment and tooth colour and shape are also important in creating an aesthetically pleasing smile.
CONCLUSIONS: There is agreement between orthodontists and lay people when scoring smiles, with non-extraction smiles scoring more favourably. The arch form in the premolar region is narrower in the extraction group compared with the non-extraction group.

220 BENDING TESTS OF VARIOUS BONDED RETAINERS

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AIM: To investigate, *in vitro,* the strength and failure pattern of various conventional retention wires and fibre reinforced composite (FRC) retainers in a three-point bending test.
MATERIALS AND METHOD: Three multi-stranded stainless steel wires (dead-soft respond 0.0175 inch; 'custom-made' multi-stranded stainless steel wire 0.0170 inch; penta-one 0.0215 inch), gold-plated (0.0215 inch) multistranded wire, and two FRC retainers (everStick®Ortho d = 0.7 and 0.9 mm) were bonded to bovine enamel specimens in a three-point bending arrangement. The specimens were divided into two groups: straight and curved orientation, where the latter represented the clinical situation. Prior to testing, the specimens were stored in distilled water at 37°C for 72 hours. The centre bovine enamel specimen was subjected to tensile loading, from a bucco-lingual direction. Load to failure and its accompanying deflection were recorded in a universal tensilometer. The failure pattern was scored using a modified Adhesive Remnant Index.
RESULTS: The load to failure was only statistically different between the multi-stranded stainless steel custom-made wire in the straight orientation and gold-plated wire in curved orientation. The deflection of the multi-stranded stainless steel custom-made wire and dead-soft respond wire showed a significant difference for the two test orientations. No statistically significant difference between failure load and displacements were found for the FRC retainers.
CONCLUSION: From a clinical perspective, occlusal forces and the induced deflections are transferred to retained lower anterior teeth. In this study, with the exception of dead-soft respond and the custom-made wire, most stainless steel retention wires gave similar results on tensile load and deflection until failure as the FRC bonded retainers.

221 LONG-TERM STABILITY IN ANGLE CLASS I MALOCCLUSIONS

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AIM: To evaluate changes in occlusion during treatment, retention and 10 years post-retention in a sample of Angle Class I malocclusion subjects.
SUBJECTS AND METHOD: Forty one subjects (22 males, 19 females) with an Angle Class I malocclusion divided into two groups, non-extraction (n = 19) and four premolar extractions (n = 22). All subjects were treated with fixed appliances. The mean pre-treatment age in the non-ex group was 13.28 years and in the ex group 12.40 years. The mean treatment times were 1.49 and 1.95 years, respectively and the mean time in retention 1.90 and 1.52 years, respectively. Plaster models pre-treatment (T1), post-treatment (T2), post-retention (T3) and 10 years post-retention (T4) were evaluated by means of the Peer Assessment Rating (PAR) Index.
RESULTS: At T1, the mean PAR score was 18.37 (range 4-33) in the non-ex group and 24.55 (range 7-41) in the ex group. The difference was significant. There was no significant difference in mean PAR score between the groups at T2, T3 and T4. There was no significant difference in mean PAR score between T3 and T4 in any of the groups. At T2, three non-ex and eight ex cases were 'greatly improved'. 13 non-ex and 12 ex cases were 'improved', three non-ex and two ex cases were

'worse-no different'. At T3, two non-ex cases worsened, three ex cases improved, while three worsened. At T4, one non-ex case improved, while three worsened; two ex cases improved, while three worsened. The end result at T4 was thus nine greatly improved (1 non-ex, 8 ex), 23 improved (13 non-ex, 10 ex), and nine worse-no different (5 non-ex, 4 ex). Long-term stability was good for 30 subjects (73.2 per cent), and three cases even improved. Of those cases that worsened, five were non-ex and three were ex cases.
CONCLUSIONS: Ten years post-retention, nine cases were greatly improved, 23 were improved and nine were worse–no different. Long-term stability was good for 30 of the cases (73.2 per cent). There was no significant difference in mean PAR score between non-ex and ex cases 10 years post-retention.

222 INVESTIGATION OF TWO DIFFERENT TYPES OF CANINE DISTALIZATION

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AIM: The first phase of treatment for premolar extraction patients is distal movement of the canines. To shorten treatment time, the technique of rapid canine retraction through distraction osteogenesis (DO) was introduced. Also in the MBT treatment philosophy, 'laceback' was introduced for canine retraction, a 'figure of eight' ligature wire, placed from the most distally banded molar to the canine. Lacebacks are routinely used to assist control of canine crowns in premolar extraction cases and in some non-extraction cases. The aim of this study was to investigate two different types of canine distalization in the MBT technique.
MATERIALS AND METHOD: Twenty-teeth in five patients (3 females, 2 males, mean age 15.7 years) whose orthodontic treatment was to be carried out with extraction of all first premolars. The upper canines were retracted using a tooth-borne rigid type distractor with the principles of DO, and the lower canines with 0.010-inch laceback ligatures. The distraction device was activated twice a day at a rate of 0.5 mm/day.
RESULTS: The distraction procedure was completed in 14 to 19 days (mean 16 ± 1.86). The anchorage loss ranged from 0 to 2.5 mm (mean 1.1 ± 0.8). Distal displacement of the upper canines ranged from 4 to 6.5 mm (mean 5.1 ± 0.87). The distracted upper canines showed a statistically significant change in axial inclination, whereas there was no statistically significant change in axial inclination of the upper first molars after distraction. In the distalization group with laceback ligatures, the distalization procedure was completed in 15 to 21 weeks (mean 17.4 ± 2.06). The anchorage loss ranged from 0 to 2.5 mm (mean 1.3 ± 0.78). Distal displacement of the lower canines ranged from 1.5 to 7 mm (mean 4.3 ± 1.79). There was no statistically significant change in axial inclination of the lower canines and lower first molars after distalization.
CONCLUSIONS: With the MBT technique, rapid canine distalization through segmental alveolar distraction is a clinically efficient method that significantly reduces overall treatment time, and laceback ligatures proved to be effective for canine distalization. The use of lacebacks for canine retraction in crowded extraction cases, minimizes tipping of the canines into the extraction sites, and provides anchorage control early in treatment.

223 ADHESION OF ORAL MICROBIAL FLORA TO ORTHODONTIC APPLIANCES

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AIM: The degree of adhesion of different forms of bacteria to materials used for orthodontic appliances can vary substantially. Oral microbiocenosis can be changed subject to the type of interaction of metal ions and resin polymers with bacterial enzyme systems. The aim of this study was to evaluate changes in oral bacterial flora and its adhesion to different types of materials for orthodontic appliances.
MATERIALS AND METHOD: Twenty healthy patients, 12-25 years of age, undergoing orthodontic treatment with metal or composite brackets. Plaque samples were collected from around the brackets with sterile cotton pellets, which were placed in transport medium for laboratory testing.
RESULTS: Colonization by the main form of *S. sanguis* on both bracket materials was similar. Plaque samples from composite brackets contained more *C. albicans* and *Enterococcus*, whereas that formed around metal brackets had more *S. milleri*, *Fusobacterium* and *Actinomyces naeslundii*. *Preuatellae intermedius* was detected in 40 per cent of plaque samples from metal brackets and 25 per cent of samples from composite brackets.
CONCLUSIONS: Both metal and composite brackets are colonized with bacteria and bacterial forms specific to each material. Colonization of brackets with oral bacterial flora is dependent on the type of bracket material. Metal brackets are colonized to a lesser extent than composite brackets.

224 CERVICAL VERTEBRAL BODY FUSIONS IN PATIENTS WITH A SKELETAL DEEP BITE

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AIM: To examine cervical column morphology in adult patients with a skeletal deep bite compared with that in an adult control group with neutral occlusion and normal craniofacial morphology.
SUBJECTS AND METHOD: The deep bite group comprised 41 patients (23 females, 18 males) aged 21-44 years, and the control group 21 subjects (15 females, 6 males) aged 23-44 years. None of the patients or controls had received orthodontic treatment. For each individual, a visual assessment of the cervical vertebral body fusion and vertebral arch deficiency of the cervical column, and measurements of craniofacial morphology, were performed on a profile radiograph.
RESULTS: In the deep bite group, 41.5 per cent had fusion of the cervical vertebrae and 9.8 per cent posterior arch deficiency. The fusion always occurred between C2 and C3. No statistically significant gender differences were found in the occurrence of morphological characteristics of the cervical column (females 43.5%, males 38.9%). Morphological deviations of the cervical column occurred significantly more often in the deep bite group compared with the control group ($P < 0.05$). Logistic regression analysis showed that the vertical jaw relationship ($P < 0.05$), overbite ($P < 0.001$) and upper incisor inclination ($P < 0.01$) were significantly correlated with fusion of the cervical vertebrae (R2 = 0.40).
CONCLUSION: Morphological deviations of the upper cervical vertebrae are not only associated with malformation of the jaws, but also with craniofacial morphology and occlusion.

225 SIZE AND SHAPE GROWTH CHANGES IN UNTREATED SUBJECTS WITH CLASS II MALOCCLUSIONS

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AIM: To compare, cephalometrically and morphometrically, the craniofacial growth characteristics between untreated subjects with a Class II division 1 malocclusion and subjects with a Class I occlusion from the pre- to the post-pubertal stages of development, as defined on the basis of a biological indicator of individual skeletal maturity (cervical vertebral maturation method).
SUBJECTS AND METHOD: The Class II division 1 sample comprised 17 subjects (11 males, 6 females) and the Class I group 17 subjects (13 males, 4 females). The lateral cephalograms of the subjects in both groups were analyzed at six consecutive stages of skeletal maturation [cervical stage (CS) 1 to CS6]. Three craniofacial regions (cranial base, maxilla and mandible) were analyzed on the lateral cephalograms of the subjects in both groups by means of thin-plate spline analysis at CS1 (pre-pubertal) and CS6 (post-pubertal). Both cross-sectional and longitudinal comparisons were performed on growth changes and on the size and shape differences between the two study groups.
RESULTS: Craniofacial growth in subjects with an untreated Class II malocclusion was essentially similar to that observed in untreated subjects with a Class I occlusion at all developmental intervals, with the exception of significantly smaller increases in mandibular length ($P < 0.001$) at the growth spurt (CS3 through CS4) and during the overall observation period (CS1 to CS6). Morphometric analysis showed an increased cranial base angulation as a typical feature of Class II malocclusions at the pre-pubertal developmental phase. Maxillary changes in shape or size were not significantly different between the two groups. Subjects with a Class II malocclusion exhibited a significant deficiency in the size of the mandible at the completion of active craniofacial growth as compared with Class I subjects.
CONCLUSIONS: Class II dentoskeletal disharmony does not exhibit a tendency to self-correction with growth.

226 SKELETAL MORPHOLOGY IN YOUNG ADULT MALES WITH CLASS III MALOCCLUSIONS

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AIM: A Class III malocclusion may be of skeletal or dentoalveolar origin. The skeletal manifestation can be due to a discrepancy of position or size of the maxilla, the mandible, or both. However, the prevalence of the discrepancy of these skeletal components in a population with a Class III malocclusion has not been studied. Therefore, the aim was to elucidate the dentoalveolar or skeletal origin of a Class III malocclusion in a group of young adult Caucasian males.
SUBJECTS AND METHOD: Young adult male Swiss recruits (n = 3358) were examined clinically for a Class III malocclusion that was defined as a molar Class III relationship of at least half cusp width per side. Seventy-four recruits (2.2%) showed a Class III malocclusion, 57 of them agreed to participate in a cephalometric and dental cast evaluation (drop-out 23%). The position of the maxilla and the mandible were determined by SNA and SNB, and their size (ANS-PNS and GoPg) were related to the anterior cranial base (SN). The sagittal intermaxillary relationship was measured by ANB and the Wits appraisal. The prevalence of dental compensation was also evaluated. It was considered that a discrepancy existed if these values deviated at least 1 SD from the normal values of Bhatia and Leighton (1993).
RESULTS: In 24.6 per cent the Class III malocclusion was of dentoalveolar and in 75.4 per cent of skeletal origin. Discrepancy in the sagittal intermaxillary relationship was found in 52.6 per cent (ANB) or 66.7 per cent (Wits). Maxillary deficiency without retrognathism was found in 8.8 per cent, and retrognathic but not a deficient maxilla in 10.5 per cent.

Mandibular excess without prognathism was present in 15.8 per cent, and mandibular prognathism without an excessive mandible in 10.5 per cent. Mandibular excess and prognathism was found in 21.1 per cent. A combination of mandibular excess and maxillary retrognathism or maxillary deficiency and mandibular prognathism represented 8.8 per cent. No correlation was found in the severity of the Class III molar relationship and the sagittal intermaxillary relationship. Dental compensation was common with proclined upper incisors in 42.1 per cent and retroclined lower incisors in 26.3 per cent.
CONCLUSIONS: In subjects with a Class III malocclusion this is of skeletal origin in approximately 75 per cent, mainly due to mandibular excess or prognathism. These findings should be taken into consideration in treatment planning and the evaluation of the treatment effects in Class III malocclusions.

227 CARIES PREVALENCE IN CLEFT PATIENTS FROM LODZ, POLAND AND ERLANGEN, GERMANY

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AIMS: To assess and compare the oral and dental status as well as the level of oral health care among Polish and German patients with cleft lip and palate (CLP) and to assess the level of compliance with oral hygiene procedures.
SUBJECTS AND METHOD: Thirty-seven patients treated in the Department of Dentistry of Developmental Age, Medical University in Lodz, Poland were examined between February and April 2004 and 63 patients treated in the Department of Orthodontics, University of Erlangen, Germany between October 2004 until August 2005. Oral and dental status was assessed by the presence of dental plaque and caries lesions. The parents of each subject were asked to complete a questionnaire relating to the frequency of tooth brushing, frequency of dental visits and the use of fluoride containing toothpaste and mouthrinses.
RESULTS: In Erlangen DT = 1.625, MT = 0.014 and FT = 2.39. In Lodz DT was 2.5, MT = 0.09 and FT = 0.75. Among the subjects with an API <40 per cent, the DMFT index was significantly higher in Polish than in German patients. In the total population of patients, a positive correlation between the value of API and caries intensity was recorded. In both countries, the majority of parents stated that their children brushed their teeth a minimum of twice a day. Optimal oral hygiene was found in 60 per cent of patients from Erlangen but in Lodz in only 19 per cent. Caries experience differed significantly between the groups of 'fluoride consumers' and 'non-consumers'. In Poland, as well as in Germany, the caries preventive procedures were similar but, according to the guidelines of each National Health Service, they are allowed to be performed more frequently in Erlangen than in Lodz. The difference in dental caries experience in the groups was a reflection of caries in the total population of Poland and Germany. Beside structural defects of the oral cavity existing in this anomaly, the high prevalence of dental erosion as well as high salivary levels of caries associated microflora in children with CLP are possible factors responsible for the higher caries incidence.
CONCLUSIONS: Caries prevalence in each group is much higher compared with the general populations and significantly higher among Polish than German cleft patients. Programmes for cleft children promoting oral health, especially aimed at plaque control, are recommended in the early stages of the child's life.

228 CORROSION AND BENDING PROPERTIES OF AS-RECEIVED ORTHODONTIC NiTi ARCHWIRES

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AIM: Different attempts have been undertaken to protect NiTi devices/appliances and thus minimize the risk of Ni-ion release. One possible alternative is sealing of the NiTi surface with synthetic coatings that are now commercially available. The aim of this study was to investigate the effects of synthetic coatings on the corrosion and bending properties of some commercially available superelastic NiTi archwires in the as-received state.
MATERIALS AND METHOD: Uncoated and the corresponding coated NiTi archwires with the dimensions 0.016, 0.018 and 0.016 × 0.016 inch from four different suppliers. Three point bending tests were been performed on 2 cm segments of the straight ends of the wires using a material testing machine (Synergie 200, MTS) with an integrated load gauge of 10 N at 38°C. Each data set included two loading cycles. The corrosion properties determined via cyclic dynamic polarization (CDP) were within –1.5 to 2 V at 2 mV/s, 37°C in ½-strong Ringer's solution (Merck).
RESULT: All wires tested exhibited excellent superelasticity. As expected, producer specific differences in the elastic bending modulus and the loaded and unloaded plateau forces were observed. Except for one brand, significant differences in these parameters were found for the uncoated and corresponding coated products. The results of CDP measurements showed no significant improvement in corrosion resistance with coating for the majority of the tested samples.
CONCLUSION: Synthetic coatings do not affect the superelasicity of NiTi archwires but may lead to different mechanical properties. Although theoretically corrosion resistance should be improved, in practice this effect is hardly noticeable, suggesting insufficient coating qualities.

229 IL-1, IL-1R, IL-6 CONCENTRATION IN GINGIVAL CREVICULAR FLUID AFTER MECHANICAL STRESS

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AIM: The early phase of orthodontic tooth movement causes an acute inflammatory response with several cytokines found in gingival crevicular fluid (GCF). The aim of this research was to determine changes in the level of IL-1, IL-1R and IL-6 in GCF proteins after application of orthodontic force.
MATERIALS AND METHOD: The measurement of the ratios of IL-1, IL-1R, IL-6 in experimental and control teeth was performed in 10 children (4 boys, 6 girls, mean age 15.4 years) after maxillary first premolar extraction. The level of IL-1, IL-1R and IL-6 was measured in the GCF of the maxillary canines following distal retraction at the mesial and distal sides, as well as at both sides of the control teeth (opposite and contralateral canines). The measurements were performed before activation and 48 and 168 hours after application of a retraction force of 250 g. The same procedure of three measurements was repeated for all patients after one month. A paper strip was inserted at both sides of the tooth at a depth of 2 mm for 30 seconds and after 1 minute the procedure was repeated for each tooth. The volume of GCF was assessed using a Periotron. The cytokines were measured immunochemically and the concentration was expressed in relation to total GCF protein.
RESULTS: The ratio of IL-1 at the distal sides of the experimental and control teeth increased from 0.57 to 1.03 after 48 hours and changed to 0.71 after 168 hours. The ratio of IL-1R at the distal side of the experimental tooth to the distal side of the control tooth increased from 0.62 to 0.78 after 48 hours and changed to 0.58 at 168 hours. No changes in IL-1 and IL-1R were noted for the mesial side. The ratio of IL-6 increased significantly; distal side from 0.30 to 0.37 after 48 hours and to 0.72 after 168 hours, as well as at the mesial side from 1.01 to 1.20 after 48 hours and to 2.08 after 168 hours.
CONCLUSIONS: The increase of IL-1, IL-1R, and IL-6 ratios in GCF after application of orthodontic force may indicate a local inflammatory response at the distal as well at the mesial side of the distalized tooth. Cytokines descended locally and stimulate bone remodelling, resorption and new bone deposition.

230 FIVE-YEAR RADIOGRAPHIC ASSESSMENT OF AUTOTRANSPLANTED TEETH

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AIM: To evaluate the radiographic status of autotransplanted teeth.
MATERIALS AND METHOD: The investigation of the patients took place at least 5 years after surgical treatment. In each patient, the contralateral teeth served as the controls. Radiographs of 81 autotransplanted teeth (TX) and 81 control teeth (TC) were taken. Caries was evaluated (0 = no, 1 = yes). The width of dental fillings was investigated (F0 = no filling, F1 = one surface, F2 = two surfaces, F3 = three surfaces).
RESULTS: Caries was found in 20 (TX) and in 23.08 (TC) per cent of the subjects. No caries was detected in 80 per cent of TX and in 76.92 per cent of TC. Restorations were found in 30.77 per cent (TX) and 80 per cent (TC) of the cases [TX F0 = 69.23%, F1= 18.46%, F2 = 7.69%, F3 = 4.62%/TC F0 = 20%, F1 = 12.31%, F2 = 18.46%, F3 = 49.32%).
CONCLUSION: No significant differences were found radiographically between the TX and TC teeth regarding caries. The TX teeth showed fewer restorations than the TC teeth. This study confirms the value of autotransplantation as a successful treatment option.

231 MUTATION SCREENING IN THREE SISTERS WITH SEVERE OLIGODONTIA

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AIMS: To describe the dentofacial phenotypes of three sisters with severe non-syndromic oligodontia, to report and discuss the mutation analysis in genes, previously shown to cause various phenotypes of oligodontia, and to also sequence two other suspected genes.
MATERIALS AND METHOD: Anamnestic data and a panoramic radiograph were taken to study the phenotype of the three sisters and their first-degree relatives. Blood samples were also taken to obtain the karyotypes and DNA samples. Karyotypes were studied by G-banding; genomic DNA was isolated from peripheral lymphocytes and mutational screening was carried out for the MSX1, PAX9, AXIN2, DLX1 and DLX2 genes.
RESULTS AND DISCUSSION: The probands' pedigree showed a recessive/possible multigenic pattern of inheritance with a healthy mother and father. Normal chromosomal karyotypes were found and, despite the severe oligodontia in all

three sisters. no mutation appeared to be present in the five genes studied so far in these patients. Although there were no clear phenotypical indications for ectodermal dysplasia in the probands and their family, one of the many minor forms could not, with certainty, be excluded. From the literature and clinical experience, it is known that, unlike cases with a monogenic causative mutation with dominant inheritance, many of the severe hypodontia cases show a more complex inheritance pattern. The aetiology most probably is multifactorial, with the contribution of multiple genetic and environmental factors. The genetic changes may be subtler at the molecular level than in dominant mutations. These changes may be present in genes that have not yet been associated with human tooth agenesis, in genes associated with syndromes or in the genes studied in this family. In fact there are several common polymorphisms in the latter genes that may be involved but these have so far not been identified.
CONCLUSIONS: In the three sisters reported, their common oligodontia phenotype is not caused by mutations in the coding regions of MSX1, PAX9, AXIN2, DLX1 or DLX2 genes, but genetic factors most probably are involved as all three are affected. Genes regulating odontogenesis need further *in vivo* and *in vitro* investigation to explain the phenotypic heterogeneity and to increase understanding of the odontogenic processes.

232 EFFECT OF CHANGES IN HORIZONTAL JAW POSITION ON INTRAORAL PRESSURE

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AIM: It is thought that the neighbouring soft tissues influence the shape of the dental arch and the position of the teeth. Although the findings of previous studies suggest that an imbalance in buccolingual pressure may be involved in mandibular molar dental compensation and asymmetry of the dental arch in subjects with facial asymmetry, the underlying mechanism has not yet been clarified. Thus, the purpose of this study was to test the following hypothesis: tongue pressure decreases on the shifted side, but increases on the non-shifted side, while cheek pressure increases on the shifted side but decreases on the non-shifted side.
SUBJECTS AND METHOD: Twelve skeletal Class I adult males without facial asymmetry. Simultaneous measurement of buccolingual pressure on the mandibular right first molar was performed using a pair of pressure sensors when the subjects experimentally shifted the mandible laterally. Buccolingual pressures were compared during the rest position (RP), right-shifted position (RS) and left-shifted position (LS). Moreover, T1-weighted magnetic resonance images of the oral structures were obtained to define the changes in the position of the tongue when the mandible was laterally shifted. Friedman and Student-Newman-Keuls tests were used to determine whether there were significant differences in intraoral pressure and the ratio of tongue pressure to cheek pressure in the three mandibular positions. A Spearman correlation coefficient by rank was used to evaluate the relationship between the amounts of displacement of the mandible and tongue.
RESULTS: Tongue pressure tended to decrease in the order: LS>RP>RS, while cheek pressure tended to increase in the order: LS<RP<RS. The tongue/cheek pressure ratio tended to decrease in the order: LS>RP>RS. There were significant positive (RS) and negative (LS) correlations between displacement of the tongue and tongue pressure, indicating that tongue pressure decreased on the shifted side, but increased on the non-shifted side. On the other hand, cheek pressure increased on the shifted side, whereas it decreased on the non-shifted side.
CONCLUSIONS: The imbalance in buccolingual pressure in the laterally shifted mandibular position may partly explain mandibular molar dental compensation and asymmetry of the dental arch in subjects with facial asymmetry.

233 BONE DENSITY AND OSTEOCLAST RECRUITMENT DURING TOOTH MOVEMENT IN OVARIECTOMIZED RATS

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AIM: An association between post-menopausal osteoporosis and the velocity of tooth movement has been proposed. However, the histomorphometric characteristics of the alveolar bone in osteoporotic rats during experimental tooth movement (ETM) have not been reported. The aim of the present study was to investigate the histological changes of the alveolar bone and osteoclastic activity during ETM of 14 days in ovariectomized (OVX) rats.
MATERIALS AND METHOD: Eighty-four adult female virgin rats were used: 42 for the OVX group, 42 for the controls, divided into six groups according to the observation time points at 0, 1, 3, 5, 7, 10 and 14 days. The OVX rats were ovariectomized bilaterally and the controls were subjected to sham surgery. The OVX model was established 3 months after surgery. ETM was accomplished unilaterally in both OVX and control rats by a NiTi closing coil spring with an initial force of 40 cN to move the maxillary first molar mesially, using the incisors as anchorage. The amount of ETM was determined by

the space between the first and second molars with a feeler gauge. The hemi-maxillae were fixed, decalcified and embedded in paraffin. Sections, 5 μm thick, were cut parasagittally. Haematoxylin and eosin and Masson's staining were performed for general histological analyisis. Osteoclasts were identified with tartrate resistant acid phosphatase staining. The number of osteoclasts was calculated at the mesial alveolar socket of the palatal-mesial root of the first molar. Bone density was quantified with ultrasound methods.
RESULTS: The OVX model was successful, with evidence of histomorphometric changes. The trabecular bone volume in the OVX group was significantly lower than in the controls ($P < 0.05$). Typical three-stage tooth movement was found. The amount of tooth movement in the OVX group was significantly greater than in the controls ($P < 0.05$). A small number of osteoclasts existed at day 0, mainly at the distal side. After force application, the number of osteoclasts increased significantly at the pressure sides of the alveolar bone in both groups ($P < 0.05$), with a faster recruitment in the OVX rats ($P < 0.05$).
CONCLUSION: Osteoporotic changes in rats had significant effects on alveolar bone density and osteoclastic activity during experimental tooth movement. Compared with the rats with normal bone metabolism, the OVX rats had a lower trabecular bone volume, faster osteoclast recruitment, and faster tooth movement.

234 TREATMENT OF CLASS III MALOCCLUSIONS WITH TWO DIFFERENT APPROACHES
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AIM: To compare the effects of two different types of treatment of Class III malocclusions.
SUBJECTS AND METHOD: Twenty-five children with an Angle Class III malocclusion. The sample was divided into two groups; group. 1 consisted of 13 children with a mean age of 10.75 ± 1.48 years treated by reverse headgear and an intraoral removable appliance, and group 2, 12 children with a mean age of 10.58 ± 1.04 years treated using intraoral magnetic devices. The mean treatment time was 9.45 ± 1.75 months for the first group and 8.75 ± 1.42 months for the second group. Pre- and post-treatment cephalograms were used to assess 17 parameters. The parameters were analysed by factorial design repeated measurements ANOVA and Duncan test for comparison of the treatment changes and interactions between time and group factors.
RESULTS: The anterior cranial base (SN) and the anterior portion of this measurement (EN), overbite, overjet, SNA, SN/GoGn, and S-Go showed significant changes during the treatment period, which were similar in both groups. The gonial angle, Co-Go, maxillary depth, and SNA showed significant differences between the two groups. Group × Time interaction was found to be significant for Co-Pg, N-M, and ANS-M. These measurements increased less in group 2.
CONCLUSION: The increase in anterior and lower face heights and mandibular length was less in patients treated with magnetic devices than those treated with reverse headgear, indicating improved control of anterior face height and mandibular length with magnetic devices, which is beneficial for Class III patients.

235 BIOLOGICAL APPROACHES TO ENHANCE DISTRACTION OSTEOGENESIS IN THE MAXILLARY SUTURE
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AIM: To examine whether local application of angiogenic and osteogenic factors could enhance distraction osteogenesis in the maxillary suture.
MATERIALS AND METHOD: Thirty-six Sprague Dawley rats, on rapid pre-maxillary suture expansion, were allotted to one control and two experimental groups. A single dose of VEGF or BMP-2 was injected into the suture 24 hours after expansion in the experimental rats. The control animals were injected with saline. The animals were sacrificed on days 3, 5 and 7. PCNA immunostaining was used to identify the replicating cells. BrdU was labelled to trace osteoblast differentiation and migration. Neovascularization was evaluated by the expression of von Willebrand factor. Bone histomorphometry was carried out to quantify the amount of new bone formation along the suture.
RESULTS: The experimental animals showed more new bone deposited along the suture on day 7 ($P < 0.05$). The increase was more evident in the VEGF than in the BMP group. Coincidently, more replicating pre-osteoblasts were recorded on days 3 and 5 in the experimental rats. Application of VEGF, but not BMP-2 led to an increase in the number of new blood vessels and an increase in the recruitment of osteoblasts on suture expansion.
CONCLUSION: Biological approaches, such as local application of angiogenic and osteogenic factors, are promising methods to enhance distraction osteogenesis in the maxillary suture. Administration of VEGF seems more powerful than BMP to induce new bone formation.

236 AUTOMATIC RECOGNITION OF ANATOMIC FEATURES ON CEPHALOGRAMS OF CHILDREN**
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AIM: To develop a system that automatically recognizes the anatomic features on the cephalograms of pre-adolescent children and to examine its practical accuracy.
MATERIALS AND METHOD: Four hundred and fifty lateral cephalograms of Japanese pre-adolescent patients (mean age: 8 years 11 months). Twenty soft tissue landmarks were located visually by an expert orthodontist. An image area, including each landmark and its adjacent anatomic structure, was transformed to a projected principal edge distribution (PPED) vector (Yagi *et al*., 2000) for 400 cephalogram images. Fifteen template vectors were generated from the 400 PPED vectors for each landmark using the vector quantization method. Each landmark was identified on the remaining 65 cephalometric images employing template matching processing with the template vectors. From these vectors, 15 templates were generated using a generalized Lloyd algorithm. The system was designed to perform pixel-by-pixel film scanning with template matching operations. The most matched position was then recognized as the landmark position and a 2.2×2.2 cm area, whose centre was the landmark position, was recognized as the anatomic structure surrounding the landmark. To examine the performance reliability of the system, 50 lateral cephalograms were examined. The areas of each system-identified anatomic structure surrounding the landmark and the positions of each system-identified landmark were compared with norms in the form of confidence ellipses. When the system-identified area overlapped the normal area, the anatomic feature recognition was designated as successful. In addition, when the system-identified point was located within a confidence limit of $\alpha = 0.01$, the landmark identification was designated as successful. Success rates for all the landmarks were calculated.
RESULTS: The system successfully identified all the specified anatomic structures in all the images and determined the landmark positions with a mean success rate of 82 per cent (50–100%).
CONCLUSION: The proposed system was confirmed to be highly accurate and reliable.

237 INFLUENCE OF CRYOPRESERVATION ON HUMAN PULPAL TISSUE *IN VITRO*: A PILOT STUDY.
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AIM: To investigate whether pulpal tissue of an immature tooth is able to survive cryopreservation, and whether the cryopreserved pulpal cells have the same growth capacity compared with non-cryopreserved pulpal cells.
MATERIALS AND METHOD: Pulpal tissue was obtained from 36 extracted immature third molars of 13 subjects (between 15-30 years of age). Each pulp was divided in two. One part was equilibrated with dimethylsulfoxide and frozen using standard cryogenic procedures. After thawing, the pulp was divided into fragments and cultured using the explant method (group A). The other part was divided in to fragments and cultured immediately without cryopreservation (group B). A cell line (consisting of fibroblasts) was considered to be successful when confluence in passage 1 was reached. For each tooth a comparison was made between the cell lines in groups A and B.
RESULTS: Due to bacterial contamination in either group A or group B, a comparison between cryopreserved and non-cryopreserved pulpal cells was impossible for 16 teeth (44%). For this reason, these teeth were excluded from the study. For the other 20 teeth, cell lines in both groups were successful and similar; even the start of outgrowth of cells seemed unretarded in the cryopreservation group.
CONCLUSION: Outgrowth of fibroblasts in group A shows that pulpal viability can be maintained during cryopreservation. Cell lines in groups A and B were very similar, indicating that the growth capacity of pulpal fibroblasts does not seem to be negatively influenced using standard cryogenic procedures. To increase the clinical relevance of this experiment, further investigation is required on pulpal viability after cryopreservation, for example to evaluate whether the diameter of the apical foramen plays a role in the amount of infiltration of the cryoprotective agent into the pulp chamber tissue.

238 UPPER INCISOR INTRUSION WITH MINI-IMPLANTS
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AIM: One of the most important aims in orthodontics is the management of anchorage. Using pre-existing prosthetic implants is not always simple because of their number, position, and bonding characteristics. The aim of this study was to verify the use of mini-implants in patients undergoing fixed orthodontic treatment who required upper incisor intrusion.
SUBJECTS AND METHOD: Twenty-five patients (12 males, 13 females) aged 14-17 years divided into two groups. The first group received mini-implant intrusion (Micerium Spa, Italy), and the second traditional fixed intrusion. The mini-implants had a diameter of 1.2 mm and a maximum length of 11 mm. The positioning should reflect anatomical structures such as: dental roots, nerves, maxillary sinus, main and secondary arteries. An implant with a small diameter is helpful in this respect. The load should be applied within one week, allowing perfect healing of the implant zone. To transfer the forces to the orthodontic appliance titanium closed springs, orthodontic wires or elastomers can be used. Patients receiving mini-implants were interviewed about discomfort and pain.

RESULTS: With this system the length of treatment can be reduced (4 months less) and simplified. In all the different applications, there were no sign of swelling or inflammation. No patient reported discomfort or pain.
CONCLUSIONS: The use of mini-implants as orthodontic anchorage is an important new treatment modality.

239 EVALUATION OF THE SOFT TISSUE PROFILE AFTER BIMAXILLARY ORTHOGNATHIC SURGERY

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AIM: To evaluate changes in the position and cross-sectional surface area (CSSA) of nasal and labial soft tissues in adult skeletal Class III patients who underwent bimaxillary orthognathic surgery (maxillary advancement and mandibular set back).
MATERIALS AND METHOD: Pre-treatment, immediate pre-operative and post-treatment lateral cephalometric radiographs obtained from 20 individuals (mean age 21.3 years at T1, 22.4 years at T2, and 23.4 years at T3). In addition to standard cephalometric craniofacial variables, upper and lower lip CSSA was also measured using a digital planimeter on the lateral cephalograms. The upper lip was divided into superior (area 1) and inferior (area 2) and lower lip into superior (area 3), middle (area 4) and inferior (area 5). Statistical analysis was performed using the Minitab statistical software package. Analysis of variance (ANOVA) and Duncan's tests were used to compare the cephalometric and planimetric measurements of bimaxillary orthognathic surgery patients at T1, T2 and T3. Paired *t*-tests were also performed to analyze changes within the periods.
RESULTS: The tip of the nose was affected less with movement of the underlying skeletal structure (0.25%), while the labiomental area (soft tissue B) moved even further backward than skeletal point B as a result of mandibular setback. The results of CSSA measurements demonstrated an opposite relationship with the linear changes. An increase in linear dimensions resulted in a decrease in CSSA in the upper lip region (areas 1 and 2), while the opposite occurred in the mandibular measurements (areas 3-5). The only exception was between the superior part of the lower labial area (area 3), L1i-VR and LLA-VR, as all those variables were decreased at the end of the treatment.
CONCLUSION: The improvement in the facial profiles of the bimaxillary surgery patients could strongly be related to the significant reduction in the lower lip area.

This study was supported by Research Foundation of Ankara University, Faculty of Dentistry (no1/2006)

240 A NOVEL ANTIMICROBIAL AGENT

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AIMS: A healthy periodontium with strong bone support is essential for optimal orthodontic tooth movement. *Actinobacillus actinomycetemcomitans* (Aa) and *Porphyromonas gingivalis* (Pg) are strongly associated with early-onset, progressive and refractory periodontal disease. These gram-negative bacteria will induce loss of the periodontal ligament and tooth supporting alveolar bone. The aims of the investigation were to study the effect of naringin on the *in vitro* growth of periodontal pathogens Aa and Pg and to determine the effect of naringin on several other oral bacteria and yeasts
MATERIALS AND METHOD: The antimicrobial effects were determined *in vitro* using the broth dilution assay. Aa and Pg grown to a density of 107 to 108 cfu/mL, were incubated with test and control solution: naringin solution in different concentrations (0.25, 0.1, and 0.0625 g/mL), or 0.2 per cent chlorhexidine as the positive control, or 0.9 per cent sodium chloride (NaCl) solution as the negative control. Aliquots for the growth assay were taken as soon as the solutions were mixed, and after 3, 6 and 24 hours of incubation in an anaerobic chamber. Colonies appearing on the blood agar plates were visually counted after 3 days for Aa and after 5 days for Pg. The minimum inhibitory concentration (MIC50) of naringin against each aerobic micro-organism was defined as the minimum concentration of naringin that reduced the optical density to 50 per cent of the negative control within 24 hours of incubation in the microplate spectrophotometer.
RESULTS: When Aa and Pg were incubated with naringin, their growth began to be inhibited at 3 hours. For Pg, the effect gradually became pronounced with time; by 24 hours complete inhibition was achieved by the 0.1 and 0.25 g/mL. Naringin also had an inhibitory effect against all bacteria and yeasts tested. The MIC50 values ranged from 0.0098 to 0.125 g/mL. Thus, naringin could be a useful compound for development as a safe and naturally occurring anti-microbial agent against periodontal disease or other oral lesions, especially during treatment with fixed orthodontic appliances.
CONCLUSION: Naringin had an *in vitro* inhibitory effect on the two tested periodontal pathogens, Aa and Pg. Relatively low concentrations of naringin have an inhibitory effect on the viability of all bacteria and yeast tested, including methicillin resistant staphylococcus aureus and *C. albicans*.

241 SIX-MONTH BOND FAILURE RATE WITH A SELF-ETCHING PRIMER

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AIM: To evaluate the clinical performance of a self-etching primer compared with a conventional two-step etch and primer.
MATERIALS AND METHOD: In 35 randomly selected patients (age range 11-23 years), 632 brackets were bonded by one operator (TT) with a split-mouth design, using Transbond Plus Self-Etching Primer (SEP: 3M Unitek, Monrovia, California, USA) or a conventional two-step etch and primer (Transbond XT, 3M Unitek). The survival rate of the brackets was estimated by Kaplan-Meier and log-rank test. The bond failure interface was determined using the Adhesive Remnant Index (ARI).
RESULTS: The failure rates of the self-etch and conventional adhesives were 3.2 and 1.3 per cent, respectively. The corresponding bracket survival curves were not found to be significantly different ($P > 0.05$). A significant difference was not observed for the ARI scores ($P > 0.05$), although a higher frequency of adhesive failure at the adhesive/enamel interface was found for the SEP.
CONCLUSION: The SEP, Transbond Plus, can be effectively used for bonding of orthodontic brackets.

242 ER, CR: YSGG LASER IRRADIATION DOES NOT ALTER THE MINERAL CONTENT OF ENAMEL

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AIM: Laser irradiation is claimed to provide acid resistance through changing the mineral content of enamel. Therefore, this study aimed to evaluate the mineral composition changes of enamel samples treated with laser irradiation *in vitro*.
MATERIALS AND METHOD: Fifteen enamel samples were obtained from five sound extracted human premolars. Three enamel discs were prepared from each tooth and each portion was assigned to either one of two different test groups, or the control group. The first and second groups were irradiated with Er,Cr:YSGG laser (Millennium; Biolase, San Clemente, California, USA) operated at 1 and 2W, respectively. The third group served as the control. The levels of five elements, calcium, phosphorus, magnesium, potassium, and sulphur, in each specimen were later analyzed using the inductively coupled plasma atomic emission spectrometry technique. Changes in the levels of the chemical elements were recorded. Differences between the groups were analyzed using the Mann-Whitney *U* test.
RESULTS: The amount of calcium was 3.61, 3.74 and 3.86 per cent respectively for the 1W, 2W and control samples. The values for phosphorus were: 3.78, 3.88 and 3.88 per cent, respectively. No statistically significant differences were observed among the groups for any of the five elements evaluated ($P > 0.05$).
CONCLUSIONS: Within the limitations of this study, laser irradiation of enamel did not significantly alter the mineral composition of enamel. Therefore, it may be concluded that laser-induced acid resistance of enamel is questionable.

243 A COMPARISON OF CRANIOFACIAL MORPHOLOGY OF BILATERAL CLEFT LIP AND PALATE PATIENTS WITH A NORMAL POPULATION

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AIM: Comparison of craniofacial morphology in bilateral cleft lip and palate (BCLP) patients with a non-cleft control group, at 15 years of age.
MATERIALS AND METHOD: Cephalometric records of 42 consecutive patients (32 males, 10 females, mean age 14.8 years) with non-syndromic complete BCLP born between 1973 and 1987. The patients were treated by the cleft teams of Erasmus Medical Centre in Rotterdam and the Vrije Universiteit Medical Centre in Amsterdam. The control group consisted of all subjects from the Nijmegen Growth Study. From this population, mean cephalometric records were used. Intra-examiner reliability was assessed. Cephalometric measurements were carried out on standardized lateral cephalograms. Differences were calculated between the BCLP and control groups by a one sample Student's *t*-test, and visually by plotting the BCLP group on growth curves of the control group. Patients outside the mean (+2SD) were then evaluated. The relationship between the cephalometric values and other variables were calculated using independent sample *t*-tests and Pearson's correlation coefficients.
RESULTS AND DISCUSSION: Between the mean of the cephalometric values of the BCLP patients and the control group, significant differences were seen. The angular vertical measurements, GoGn/SN, SN/FFH and Sppl/AB, were larger in the BCLP group, while the sagittal measurements, ANB, SNA and SNB, were smaller. Pearson correlations coefficients

were calculated between ANB on the one hand and number of operators, number of operations before 15 years of age, and age on the other. All these coefficients were not significant. The small incidence of patients with a BCLP makes comparison and evaluation of varying methods of treatment difficult. Therefore no strong conclusions can be made. The values of the BCLP patients differed significantly from the control group. This tendency towards a smaller angle in sagittal measurements and a larger angle in vertical measurements is in agreement with the findings of Trotman and Ross (1993) and Friede and Pruzansky (1985).
CONCLUSIONS: BCLP patients treated in Amsterdam and Rotterdam cleft centres differ significantly from the control group. Class III development and a smaller maxilla can be seen in the sagittal direction. The vertical measurements indicate a more divergent growth pattern. Non-significant correlations exist between ANB, date of birth, number of operations and operators.

244 QUANTITATIVE ULTRASOUND IMAGING OF HEALTHY LIP AND REPAIRED CLEFT LIP

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AIMS: To investigate the feasibility of differentiating the various structures in the healthy lip by qualitative and quantitative ultrasound imaging, in both relaxed and contracted state, and to qualitatively compare these results with those obtained in repaired cleft lip subjects. For the characterisation of the different tissues of the lip, new methods were introduced.
MATERIALS AND METHOD: Echographic images of the upper lip were obtained of five young adults (three healthy subjects and two cleft patients) using a linear array transducer (7-11 MHz bandwidth) and a non-contact gel coupling. Tissue dimensions were measured using callipers. Echo levels were calibrated and corrected for beam characteristics, gel path and tissue attenuation using a tissue-mimicking phantom.
RESULTS: At the central position of the philtrum, mean [standard deviation (sd)] thickness of the lip loose connective tissue layer, orbicularis oris muscle and dense connective tissue layer the in healthy lip at rest was 4.0 (0.1), 2.3 (0.7) and 2.2 (0.7) mm, respectively, and 4.1 (0.9), 3.8 (1.7) and 2.6 (0.6) mm, respectively in the contracted lip. Mean (sd) echo level of muscle and lip dense connective tissue layer, with respect to echo level of lip loose connective tissue layer was, in a relaxed condition: –19.3 (0.6) dB and –10.7 (4.0) dB, and in a contracted state: –20.7 (1.5) dB and –7.7 (2.3) dB, respectively. The repaired upper lip of the cleft patients showed interruptions of the continuity of the orbicularis oris muscle on the images. Based on the echo level, the interruptions can most likely be attributed to scar tissue. A more detailed visualisation of the discontinuity of the muscle was possible using colour coding.
CONCLUSIONS: Quantitative assessment of thickness and echo level of various lip tissues is feasible after correct calibration of the echographic equipment. The diagnostic potentials of this method for non-invasive evaluation of the outcome of cleft lip reconstruction are promising.

245 ELIMINATION OF *CANDIDA ALBICAN* BIOFILMS FROM REMOVABLE ORTHODONTIC APPLIANCES

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AIM: Orthodontic treatment often involves the use of removable orthodontic appliances (ROA). Most of these appliances comprise acrylic or other porous materials that can be colonised with micro-organisms such as *C. albicans*, *S. aureus* and *P. aeruginosa*. Once attached to the ROA, these micro-organisms will frequently form a biofilm. There is growing evidence that *C. albican* biofilms play an essential role in the development of stomatitis and although the disease is more common in elderly patients, young children wearing ROA often suffer from stomatitis symptoms. Efficient sterilization of ROA using disinfectants and antiseptics is considered to be essential. In the present study the *in vitro* efficacy of a novel effervescent tablet for routine cleansing and disinfection of ROA was investigated.
MATERIALS AND METHOD: The *in vitro* activity (15 minutes treatment at 45°C) of Medical OrthoJunior™ (MST Laboratories, Liechtenstein) was measured against *C. albicans*, *P. aeruginosa* and *S. aureus* biofilms. Biofilms were formed on poly(methyl methacrylate (PMMA) disks under standardized flow conditions, using the modified Robbins device. In addition, the activity of Medical OrthoJunior™ against various microbial biofilms formed on other surfaces, including polystyrene and medical grade silicone were determined. For the negative control, biofilms were exposed to H_2O (45° for 15 minutes).
RESULTS: The data showed that treatment of PMMA disks with Medical OrthoJunior™ resulted in >99.99 per cent reduction in *C. albicans* biomass compared with the control treatment ($P < 0.001$). In addition, it also had a high activity against biofilms of *P. aeruginosa* and *S. aureus* formed on silicone and *C. albicans* and *S. aureus* biofilms formed on polystyrene ($P < 0.001$).

CONCLUSION: Since Medical OrthoJunior™ does not cause any metal corrosion, these effervescent tablets are suitable for routine cleansing and disinfection of metal containing ROA. In addition, the data clearly indicate that treatment with Medical OrthoJunior™ allows the efficient removal of microbial biofilms from ROA. Clinical trials are ongoing to document the subsequent beneficial effects in the prevention and treatment of stomatitis symptoms, including halitosis.

246 ANTERO-POSTERIOR AND VERTICAL GROWTH OF THE MAXILLARY TUBEROSITY FROM 6 TO 20 YEARS OF AGE

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AIM: Growth of the maxillary tuberosity (MT) during the first two decades of life has not been thoroughly investigated, although questions, such as feasibility to correct Class II malocclusions by molar distalization or enhancing maxillary advancement in Class III malocclusions, are related to the inherited growth potential in this region. The objective of this study was to define and quantify the growth pattern of the MT in untreated subjects from 6 to 20 years of age.
MATERIALS AND METHOD: Normal development of the MT and posterior dentition was examined on 189 panoramic radiographs of untreated subjects, divided into six age groups: 6-7, 8-9, 10-11, 12-13, 14-15, and 16-20 years. The radiographs were randomly selected and excluded if artefacts were present. A special analysis was developed that detected changes of 21 linear, angular and area measurements. These variables were statistically compared regarding chronological age, molar eruption phase, and molar root development stage using ANOVA with Tukey's *post hoc* test.
RESULTS: From 6 to 20 years of age, the MT to key ridge distance increased by 3.94 mm (+31%), MT to pterygoid plate distance decreased by 5.11 mm (–50%), the vertical increase at the first molar was 14.64 mm (+42%), the MT area increased by 127 mm^2 (+51%), the maxillary sinus increased by 5.81 mm (18%), while the anterior region of the maxilla basically did not change (–0.8 mm = –4%). Peak MT horizontal, vertical and area growth occurred from 8.5 to 10.5 years of age. However, peak sinus expansion occurred from 6.5 to 8.5 years and from 14.5 to 18 years. Molar root development was a better indicator than molar eruption phase to estimate MT growth.
CONCLUSIONS: Dividing the maxilla into three regions of posterior, mid and anterior demonstrated that the posterior MT region was the major growth site of the maxilla and a substantial contributor to craniofacial development. In the mid region, some antero-posterior pneumatization of the maxillary sinus occurred and in the anterior region there was no growth potential. The augmented growth potential of the MT should be used as part of the orthodontic treatment plan, especially during the mixed dentition period.

This study was supported by grant No. I-735-71.2 from the German-Israeli-Foundation.

247 DIFFUSE DAMAGE IN PORCINE ALVEOLAR BONE WITH AND WITHOUT ORTHODONTIC LOADING

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AIM: To evaluate the occurrence of bone diffuse damage in porcine alveolar bone with and without the application of an orthodontic load.
MATERIALS AND METHOD: Twenty-five, 3-month old, male Danish land-race pigs in whom the lower right central incisor was moved mesially with a force of 150 cN. The contralateral incisor was not treated and served as the internal control. After 1, 2, 4, 7 and 15 days of treatment the mandibles were removed and the regions containing the right and left lower incisors were excised, and stained *en bloc* without decalcification. Mesio-distal vertical 100 μm thick sections were cut through the lower incisors on both sides. The presence of microdamage on the buccal and lingual sides of both treated and untreated teeth was detected and expressed as microdamage density (# per mm^2). The mesial and distal sides were statistically compared within and between the groups using paired non-parametric statistics.
RESULTS: There was no significant difference in diffuse damage between the treated and untreated side. However, due to the presence of dropouts at days 4, 7, and 15 caused by appliance failure, there were not an equal number of cases in each group. This, together with a large variation of the data, might have resulted in a type II error. A common observation was higher diffuse damage density at the distal sides than the mesial sides, especially at day 1. Since diffuse damage was mostly observed in bone area submitted to tensile strains, this could be ascribed to the functional load of the teeth during mastication. The periodontal fibres in the distal sides were in fact orientated in the same direction as the diffuse damage observed. At days 1 and 2 the median values of diffuse damage on the distal area of the loaded teeth (tensile strains area) were larger than on the corresponding untreated side. From day 4 on, the values on the treated side remained unchanged, while on the untreated side diffuse damage showed a tendency towards increased values. This might be due to changed chewing function towards the untreated side.

CONCLUSION: Diffuse damage, associated with tensile strains, is more often present on the distal than on the mesial side of both treated and untreated sides. The application of an orthodontic load seems to modify the distribution pattern of diffuse damage. These observations need further confirmation by a study with larger samples of experimental animals.

248 HOW CLEAN ARE OUR HANDS? AN AUDIT OF HAND HYGIENE AMONGST ORTHODONTIC STAFF

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AIMS: Recent media attention in the United Kingdom has increased patient awareness of the risk of hospital-acquired infections. It is therefore important that orthodontic staff practice, and are seen to practice, good hand hygiene. An investigation into hand hygiene was carried out, with two main aims: to ensure clinical areas in the orthodontic department contain suitable equipment for staff to practice good hand hygiene and to ensure all staff in the department cleaned their hands appropriately.
MATERIALS AND METHOD: An audit of clinical areas and staff in the Department of Orthodontics, James Cook University Hospital. The 'gold' standard was 100 per cent compliance with South Tees Hospitals NHS Trust Hand Hygiene Policy, which sets out requirements for both clinical areas and staff. Clinical areas were audited using the Trust's Hand Hygiene Policy audit tool. Hand hygiene practices amongst all clinical staff were audited via an anonymous questionnaire.
RESULTS: The audit of clinical areas revealed that approved hand cream and notices reminding staff of the importance of hand hygiene were required. Questioning of staff revealed a high level of compliance with the Hand Hygiene Policy, however, some areas of concern were identified. 1. Some staff did not remove nail varnish, hand jewellery or watches prior to cleaning hands. 2. Many staff did not know how to use alcohol gel appropriately. 3. Most staff did not use hand cream at the end of clinical sessions and were unaware that it would help to prevent allergies.
CONCLUSIONS: Hand cream and hand hygiene reminder notices were placed in all clinical areas to facilitate good hand hygiene practice. Hand hygiene training, tailored to address the areas of concern identified by the audit, was given to all orthodontic staff by the Hospital Infection Control Team. Re-audit is planned in six months, to ensure that hand hygiene practices have improved as a result of both the improvements to the clinical areas and the training provided to staff.

249 AGE-RELATED CHANGES IN MICROARCHITECTURE AND MINERALIZATION OF CONDYLAR BONE

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AIM: Mandibular bone growth and development have been a focus in orthodontic research for many years. However, information on changes in its internal architecture is scarce. The aim of the present study was to analyze the age-related changes in the microarchitecture of cancellous bone in the porcine mandibular condyle three-dimensionally, and to quantify the changes in its mineralization.
MATERIALS AND METHOD: The left mandibular condyles of eight domestic pigs, aged between 8 weeks pre-partum and 108 weeks post-partum, were analysed using microcomputed tomography with an isotropic spatial resolution of 10 μm. Architectural parameters of the cancellous bone were quantified in cubic volumes of interest defined in specific regions of each condyle. The degree of mineralization of bone (DMB) was determined using a calibration phantom containing hydroxyapatite with known densities as a reference. The distribution of DMB within individual trabeculae was quantified using a specifically designed algorithm. Layers with a thickness of 7-8 μm were consecutively peeled off from the trabecular surfaces towards the cores and the mean DMB was subsequently calculated for each layer.
RESULTS: The trabecular number decreased from 10 to 3 trabeculae/mm during development, whereas both trabecular thickness and distance between the trabeculae increased. Furthermore, the bone surface to volume ratio decreased with age. Mean DMB increased during development. The bone at the surfaces of the trabeculae was also clearly less mineralised compared with the bone in their cores. However, the trabecular surfaces were more highly mineralised in the older compared with the younger condyles. In combination with the observed decrease in the relative size of the trabecular surface, these quantitative data indicate a decrease in remodelling activity during development.
CONCLUSIONS: The largest changes in microarchitecture and mineralization occur during the first 40 post-natal weeks, which is in accordance with general porcine growth and development. The increase in local differences in DMB between the surfaces and the cores of individual trabeculae is caused by a stronger increase in DMB in their cores than at their surfaces.

250 BONE INDUCTION USING PUERARIN

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AIM: Puerarin is one of the major phytoestrogens isolated from Pueraria lobata, a Chinese medicine known as Gegen. The aim of this investigation was to compare the amount of new bone produced by puerarin in collagen matrix (carrier) to that produced by the collagen matrix alone.
MATERIALS AND METHOD: Eighteen bone defects, 5 × 10 mm, were created in the parietal bone of nine New Zealand White rabbits. In the experimental group, six defects were grafted with puerarin solution mixed with collagen matrix. In the control groups, six defects were grafted with collagen matrix alone (active control) and six were left empty (passive control). The animals were killed on day 14 and the defects were dissected and prepared for histological assessment. Serial sections were cut across each defect. Quantitative analysis of new bone formation was made on 100 sections (50 sections for each group) using image analysis.
RESULTS: A total of 554 per cent more new bone was present in defects grafted with puerarin in collagen matrix than those grafted with collagen matrix alone. No bone was formed in the passive control group.
CONCLUSIONS: Puerarin in collagen matrix has the effect of increasing new bone formation locally and can be used for bone grafting or for bone induction.

251 MORPHOLOGICAL QUANTIFICATION OF THE DENTAL ARCH AND THE ALVEOLAR BASAL ARCH**
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AIM: To develop a morphometric method for quantifying the shape of the dental arch (DA), and to describe morphological relationship between the DA and the alveolar basal arch (ABA) in subjects with a normal occlusion.
SUBJECTS AND METHOD: Fifty Japanese volunteers (35 males, 15 females) from 23 to 25 years of age (mean = 23.5, SD = 0.5) with a normal occlusion. The measurement procedures and analyses were as follows: 1) A cranial reference was established through facebow transfer and three-dimensional co-ordinates of centric stops were measured on the dental casts using a Microscribe-3D (Immersion Co.). 2) A plane was fitted to these points by the least square method and its angles (elevation and roll) to the cranial reference were determined. 3) Approximation for the DA was achieved on the plane by repeating rotation and fitting of a fourth-order polynomial curve without odd-order terms ($Y = a \times 4 + b \times 2$), and the fittest coefficients (a, b) and rotational angle (Azimuth) of the curve were determined. 4) The same procedures were also carried out for the ABA.
RESULTS: The residual standard deviations (SD) ranged from 0.5 to 1.0, indicating that the average distance from the points to the curve was less than 1.0 mm in normal occlusions. Mean (SD) of a (mm^{-3}), b (mm^{-1}), Elevation, roll and Azimuth (degrees) were; 2.59×10^{-5} (1.38×10^{-5}), 2.82×10^{-2} (0.89×10^{-2}), –13.13 (5.95), 0.20 (1.71), –0.82 (1.82) in DA, 1.48×10^{-5} (0.66×10^{-5}), 1.22×10^{-2} (0.64×10^{-2}), 2.36 (5.42), 0.11 (1.95), –0.48 (1.67) in the upper ABA, 1.00×10^{-5} (0.45×10^{-5}), 1.84×10^{-2} (0.46×10^{-2}), –17.40 (6.07), 0.65 (1.69), –1.12 (1.77) in the lower ABA, respectively. The quadratic term (a) is related to a square arch form (U-shape), while the quadratic term (b) is related to an acuminate (tapering gradually to a sharp point, as in the tips of certain leaves) arch form (V-shape). Thus, a new index ($P = a1/3/b$) was employed for cluster analysis. Consequently, the upper DA was divided into two groups by $P = 2.5$. Regression analysis revealed that if ABA was transformed into DA by transverse (m) and longitudinal (n) expansion, regression equations were represented as $m^2 = cn + d$, and c, d were 0.108, 1.467 in case of $P \geq 2.5$ ($R2 = 0.97$), 0.362, 0.538 in case of $P < 2.5$ ($R2 = 0.98$) for the upper DA, and 0.342, 0.244 ($R2 = 0.99$) for the lower DA (any P), respectively. These results suggested that the shape of DA may be predicted from that of ABA.
CONCLUSION: This method may be useful to establish a more precise diagnosis and a suitable treatment goal for each patient.

252 PSYCHOLOGICAL TENDENCIES OF PATIENTS WITH DENTOFACIAL DEFORMITY**
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AIM: To investigate the psychological impact of facial appearance for patients with dentofacial deformity and to identify such patients' psychological tendencies.
SUBJECTS AND METHOD: Twenty-one adults (13 females, 8 males; average age 26 years) who required orthognathic surgery. Questionnaires and automated psychological tests (MINI) were used to measure the psychological status of each patient. The subjects were classified on the basis of four groups: (1) patients who worried about their facial appearance when it was pointed out by others; (2) patients who did not worry about their facial appearance when it was pointed out; (3) those who consider their dentofacial deformity as a constant source of stress; (4) patients who did not consider their dentofacial deformity as a constant source of stress. Each patient was grouped by gender and compared by MINI-scales.

RESULTS: Fifteen patients (71.4%) (8 females, 61.5%; 7 males; 87.5%) belonged to group 1 and 13 (63.9%) (10 females, 76.9%; 3 males; 33.3%) to group 3. Using MINI, patients who were classified as 1 and 3 had significant schizophrenia, social introversion, and paranoia. The levels psychosomatic and weak personal relationship areas of patients suitable for (1) or (3) were greater than those of patients suitable for either 2 or 4. Some psychological tendency was observed in the patients with dentofacial deformity.
CONCLUSIONS: More than 50 per cent of patients with a dentofacial deformity are 'obsessed' with their faces. They are always anxious about how they are seen by others, and also care a significant amount about their body image. They also show a tendency toward weak inter-personal relationships. Furthermore, females had a stronger tendency to consider dentofacial deformities as a source of stress, whereas males generally worried less about their facial appearance except when it was pointed out by other people.

253 ENAMEL ETCHING FOR BONDING FIXED ORTHODONTIC BRACKETS – A SYSTEMATIC REVIEW

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AIM: To determine the appropriate concentration and duration of conventional etchants, and to compare the use of a one-step self-etching technique (SET) with a conventional etching technique (CET), for bonding fixed orthodontic appliances.
MATERIALS AND METHOD: An electronic search of the Cochrane Oral Health Group Trials Register; Medline; EMbase and the CBMdisc was carried out, together with a hand-search of relevant conference papers and Chinese dental journals. Two reviewers independently selected randomized and controlled clinical trials (RCT, CCT), evaluated their quality and extracted data. Disagreements were resolved by discussion or judged by a third person. These data were analyzed using RevMan 4.2.8 software provided by the Cochrane Collaboration. Bond failure was the primary outcome investigated.
RESULTS: Four RCTs and seven CCTs involving 411 participants with 6468 teeth were identified. All were of a split-mouth design. Meta-analysis revealed, in the CET groups, no significant difference for bracket bond failure rate between groups using 37 per cent phosphoric acid (H_3PO_4) etching for 15 seconds compared with 60 seconds (RR 1.09, 95% CI 0.82-1.45, $P = 0.56$); Significant differences existed in bond strength between the groups for a complete dental arch of orthodontic brackets using 37 per cent H_3PO_4 when compared with 15 and 2 per cent H_3PO_4 with adequate etching time (Peto OR 2.22, 95% CI 1.02-4.86, $P = 0.05$). Orthodontic brackets bonded only to anterior teeth showed no significant differences (OR 1.90, 95% CI 0.75-4.85, $P = 0.18$). There were no statistically significant differences in bond failure rate between the SET and CET groups (OR 2.62, 95% CI 0.68-10.06, $P = 0.16$), however, the bond effect varied among different manufactured types of self-etching primer. No recommendations could be made between clinical effect using CET and SET. Many of the studies had compromised methodological quality and further research is required to confirm these findings.
CONCLUSION: Shortening etching duration of H_3PO_4 from 30~60 seconds to 15 seconds or reducing the concentration of H_3PO_4 from 37 to 15 per cent should be considered for anterior bracket bonding. In complete dental arch bonding, reduction of etching time should also be considered, although the concentration of H_3PO_4 should not be reduced, because it may increase the risk of bond failures. A short etching time, often less than the manufacturer recommends, may be indicated from the present analysis.

254 EFFECTS OF HEAT TREATMENT ON THE LOAD-DEFLECTION PROPERTIES OF NiTi WIRE

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AIM: Nickel-titanium (NiTi) alloy wire possesses excellent spring-back properties, shape memory and superelasticity. In order to adapt this wire to clinical use, it is necessary to bend as well as to control its superelastic force. The purpose of this study was to evaluate the effects of heat treatment on the load-deflection properties and transitional temperature range (TTR) of NiTi wires.
MATERIALS AND METHOD: NiTi wires with different diameters (0.016 × 0.022, 0.018 × 0.025 and 0.0215 × 0.028 inch) were used. The samples were divided into four groups as follows: group 1, posterior segment of wire (24 mm) without heat treatment; group 2, posterior segment of wire (24 mm) with heat treatment only; group 3, anterior segment with bending and heat treatment; group 4, anterior segment with bending and 1 second of heat treatment. A three-point bending test was used to evaluate the change in the load-deflection curve and differential scanning calorimetry to check the change of Af temperature.
RESULTS: 1. In the three point bending test, NiTi wires with heat treatment only had a higher load-deflection curve and loading and unloading plateau than NiTi wires without heat treatment; 2. NiTi wires with heat treatment had a lower Af temperature than NiTi wires without heat treatment; 3. NiTi wires with heat treatment and bending had a higher load-deflection curve than NiTi wires with or without heat treatment; 4. NiTi with heat treatment of more than 1 second and

bending had the highest load-deflection curve; 5. NiTi wires with heat treatment and bending had a lower Af temperature; 6. NiTi wires with heat treatment of more than 1 second and bending had the lowest Af temperature.

255 EFFECT OF LOW LEVEL LASER ON BONE REMODELLING AFTER MEDIAN DIASTEMA CLOSURE

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AIMS: To evaluate the effect of low level laser therapy (LLLT) on bone density after median diastema closure, and to determine whether increased density will help maintain a closed diastema after treatment.
SUBJECTS AND METHOD: Fourteen patients (3 males, 11 females, aged 22 ± 4.78 years with a median diastema of 6.79 ± 2.28 mm randomly allocated to either a laser or a non-laser group (n = 7). When the diastemas were closed, and before debonding, the patients in the laser group were exposed to LLLT (GaAs) for three sessions, three minutes each, every second day. After debonding, all patients had only a removable Hawley appliance. Standardized periapical radiographs of the maxillary central incisors were taken immediately after closure (baseline record) and at 15 and 45 days, and 3 and 6 months afterwards. Mean bone density (interdental and distal areas of the central incisors) and linear distances from the cemento-enamel junction to the alveolar crest (mesial surfaces of the central incisors) was measured using Digora software. An independent *t*-test was used to compare the mean percentage changes of bone density and linear distances between the groups. A correlation coefficient was used to correlate mean bone density to diastema size.
RESULTS: Statistical analysis revealed significant differences between the groups at 15 days and 6 months. The percentage change in bone density in the laser group was significantly greater than in the non-laser group. At 15 days, only the interdental area showed significant changes, but at 6 months, all investigated areas demonstrated increased bone density. The linear measurements showed a significant decrease in the laser group at 6 months, indicating a stimulatory bone effect of the LLLT. There was a negative, but non-significant correlation between diastema size (0.47 ± 0.29 mm) and bone density in the laser group at 6 months. These findings suggest that the maximum effect of LLLT was more evident at the longer follow-up period of 6 months, although laser application stimulated bone activity in the early periods (15 days), as evidenced by increased bone density.
CONCLUSION: LLLT induced increased bone density and retained a closed median diastema up to 6 months; however, longer follow-up periods are necessary to evaluate its long-term effect. It is probable that an additional dose of LLLT might play a role in the maintenance of increased bone density and diastema closure.

256 A BIOMECHANICAL AND CLINICAL STUDY OF ANCHORAGE REINFORCEMENT WITH INTRUSION ARCHES

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AIM: A number of different strategies have been proposed to prevent side-effects during canine retraction. It was the aim of this study to biomechanically analyse the applicability of an intrusion arch for anchorage reinforcement and overbite control during canine retraction employing sliding mechanics on a continuous archwire.
MATERIALS AND METHOD: Simulated canine retraction was performed experimentally with a combined intrusion arch/continuous archwire device using the Orthodontic Measurement and Simulation System. The force systems on the anterior and posterior segments as well as on the canine were measured three-dimensionally. Canine retractions were simulated with an intrusion arch adjusted to 20, 30, and 40 degrees, and without an intrusion arch. Twenty patients were selected and treated with the same device combinations. Subsequently, clinical tooth movements were determined on cephalograms and by digitising the surfaces of the plaster casts using a laser scanner for three-dimensional tooth registration.
RESULTS: Biomechanical analysis showed that without an intrusion arch, the anchorage segment reacted with an anterior tipping of around 0.5 degrees. Applying the intrusion arch with 20 and 30 degrees resulted in slight posterior tipping and posterior movement (0.1 mm, 0.3°) of the molars. The intrusion arch with 40 degrees activation generated a more distinct movement of the anchorage unit (almost 0.2 mm, 0.8°). With increasing activation of the intrusion arch, posterior tipping of the anterior segment was reduced, and the incisors were slightly intruded. The clinical results showed that the intrusion arch activated by 30 degrees had similar anchorage reinforcement as a headgear during canine retraction. Simultaneously a good overbite control was accomplished.
CONCLUSIONS: Applying sound biomechanical principles to perform canine retraction is a reliable way to achieve predictable results with minimal side-effects.

Support by the German Academic Exchange Service (DAAD) is gratefully acknowledged.

257 A COMPARISON BETWEEN ANTEROPOSTERIOR DENTAL ARCH AND JAW BASE RELATIONSHIPS

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AIM: To study the association between the anteroposterior dental arch and jaw base relationships.
MATERIALS AND METHOD: Study casts and lateral cephalograms obtained from a random sample of 306 12-year old Chinese children who were a part of large population survey in Hong Kong. Angle's classification (Class I, II and III) of the permanent first molars was used to assess the dental arch relationship from the study casts, and the jaw base relationship was assessed from the lateral cephalograms using linear (Wits analysis) and angular (ANB) measurements. A Class I jaw base relationship was defined as the mean ± 1SD, Class II > mean +1 SD, and Class III < mean –1 SD. Association between dental arch classification and jaw base relationship classification was assessed using Fisher's exact test.
RESULTS: The dental arch and jaw base relationships coincided in 66 per cent with Wits analysis, and in 60 per cent with ANB. The jaw base relationship assessed with Wits analysis was significantly associated with the dental arch relationship for Class I ($P < 0.01$), Class II ($P < 0.001$) and Class III ($P < 0.01$), whereas with ANB the dental arch and jaw base relationships were associated only for Class II ($P < 0.01$).
CONCLUSION: The anteroposterior dental arch and jaw base relationships did not match in one in three individuals. The linear measurement in assessment of the jaw base relationship showed strong association for all three categories, whereas for the angular measurement there was no marked association to dental arch relationship in two of the categories. This indicated that linear measurement of anteroposterior jaw base relationship is a more valid reflection of the dental arch relationship than the angular measurement.

258 ENAMEL SURFACE QUALITY AND SUBSTANCE LOSS USING AN OSCILLATING DEVICE FOR STRIPPING

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AIM: Interproximal enamel reduction (IPR) is an approved method to resolve, for example, dental crowding. There are various techniques for the reduction of tooth size. The purpose of this *in vitro* study was to evaluate surface conditions as well as the loss of enamel caused by oscillating diamond-coated segmented discs and subsequent polishing with rotating discs.
MATERIALS AND METHOD: Seventy-five extracted human lower anterior teeth with sound enamel surfaces. After random allocation to five groups of 15 teeth (2 canines, 13 incisors) the teeth were mounted in a model tray system with tight interproximal contact. IPR was performed with an oscillating handpiece at 40 000 rpm (O-Drive System, KaVo). While group 5 served as the control, groups 1-4 underwent different stripping/polishing regimes: group 1: medium-coated disc segment (Komet, thickness 0.3 mm), no polishing; group 2: fine-coated disc segment (0.3 mm), no polishing; groups 3 and 4: fine diamond-coated disc and fine and ultrafine alumina disks for finishing (Compo-Clips, Brasseler). For group 3, both Compo-Clips were used with water cooling for 30 seconds each at 10 000 rpm. The Compo-Clips in group 4 were moistened with Elmex gelée and were used as in group 3. With a sliding digital calliper, the mesiodistal widths of the teeth were measured after each stripping/polishing step to determine differences between mesial and distal substance loss. Surface quality was determined with a scanning electron microscope at ×300 magnification with a scoring system ranging from 1 (very good) to 5 (very poor).
RESULTS: Mean values of surface quality differed significantly between the groups. Group 1 showed the poorest results, mean score of 4.89; groups 2 and 4 performed better with average scores of 3.89 and 4.04, respectively; group 3 (1.71) showed statistically significantly better results even than the control group (2.29). No differences were found between mesial and distal substance loss for both stripping and polishing. Average substance loss for polishing ranged between 0.02 and 0.04 mm.
CONCLUSION: After polishing enamel surfaces can even be smoother than untreated enamel. If performed correctly, substance loss is similar on each side of the interproximal contact and corresponds approximately to the thickness of the segment disc. Substance loss through polishing is negligible.