

ABSTRACTS

OF LECTURES

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1 ORTHODONTIC EXPERIENCES WITH PALATAL IMPLANTS: RESULTS OF A CLINICAL STUDY

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AIM: To analyse endosteal palatal implants for solving anchorage problems in a group of patients undergoing orthodontic treatment.

SUBJECTS AND METHOD: In 50 patients the application of endosteal palatal implants for orthodontic anchorage was performed. In principle, two different treatment aims were pursued: space closure following extraction of premolars and molars, and distalization of lateral teeth in the maxilla in subjects with a Class II molar relationship. The endosteal implants were inserted at different inclinations, mostly in the anterior palatal roof of the maxilla. The fixation of the palatal arch, connected with the implant to the pair of teeth to be anchored, was varied due to previous biomechanical studies and results.

RESULTS: Clinically sufficient stability of the palatal implants was achieved with a more axial loading of the implants and a more posterior anchorage of the palatal arch. In cases of extractions and with distalization of the lateral teeth it was found that with horizontal loading of the implants and dental fixation of the palatal arch close to the implants, clinically there was a loss of anchorage and radiologically a loss of bone in the peri-implant region.

DISCUSSION: With knowledge of biomechanical criteria, such as axial loading of implants, posterior dental anchorage of the palatal arch, pre-orthodontic passive application of the palatal arch between the implant and the teeth to be anchored, as well as progressive loading of the implant, the endosteal orthodontic implant could be an essential completion of compliance independent instruments for orthodontic treatment.

2 PERIODONTAL REACTION TO LABIAL MOVEMENT OF LOWER INCISORS—RECESSIONS?

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BACKGROUND: Labial movement of lower incisors (LM) is considered a risk for gingival recession (GR), but is often needed to avoid extraction. In a case control study it was shown that LM resulted in a trend towards a higher prevalence of GR.

AIM: To investigate whether any skeletal, occlusal or soft tissue parameters are risk factors for labial recession of lower incisors in adults undergoing LM as part of orthodontic treatment.

SUBJECTS AND METHODS: One hundred and fifty adult patients (mean age = 33.7 ± 9.5 years) treated non-extraction with fixed appliances, were studied before and after treatment. Lateral headfilms, study casts and intraoral slides were analysed with respect to the amount of pre-treatment overjet, overbite, degree of crowding, presence of tooth rotation, canine relationship, vertical face height, and position of the lower incisor to A/Pog and ML lines. Pre-existing GR, width of keratinized gingiva, gingival biotype, gingival inflammation and visual plaque accumulation were recorded on standard intraoral slides. The extent of labial movement was assessed on cast measurements before and after treatment. The variables included in a logistic regression analysis as possible predictors of GR were identified with a bivariate correlation analysis. Only those with a significant bivariate association were included in the logistic regression analysis. This led to the following variables being evaluated as possible predictors: Overjet (≤ 3 mm/ >3 mm), mean width of keratinized gingiva (≤ 3.45 mm/ >3.45), biotype (thin in all 4 incisors/at least 1 thick) and inflammation (none/at least one incisor with inflammation). **RESULTS:** No significant increase in mean GR of the four lower incisors was observed during treatment. The prevalence of GR >0.1 mm increased from 21.5 per cent before to 33.3 per cent after treatment ($P < 0.05$). This could however be ascribed to the changes that occurred in a few of the patients studied. Only 2.8 per cent of the patients acquired recessions >2 mm. Logistic regression analysis showed that a wide zone of keratinized gingiva was negatively associated with GR (OR = 0.40) as was the presence of gingival inflammation (OR = 0.18). None of the orthodontically related variables were significantly associated with GR.

CONCLUSIONS: This study indicates that the 'myth' regarding the risk of periodontal damage secondary to protrusion of incisors is unfounded. None of the orthodontic variables were related to GR. The negative association between the presence of inflammation before treatment and GR could be explained by the fact that the oral hygiene of these patients was given special attention during therapy. The observation of a negative association between GR and the width of the keratinized gingiva corroborates several previous studies.

3 CHANGES IN THE MECHANICAL ADVANTAGE OF THE MASSETER AND TEMPORAL MUSCLES AND IN THE NUMBER AND INTENSITY OF OCCLUSAL CONTACTS FOLLOWING HERBST APPLIANCE TREATMENT OF CLASS II DIVISION 1 MALOCCLUSIONS

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AIMS: To determine if the mechanical advantage of the masseter and temporal muscles is altered and to assess occlusal contacts following treatment of Class II division 1 malocclusions by means of the Herbst appliance.

SUBJECTS: Twenty-five consecutive children (6 female and 19 male) with Class II division 1 malocclusions corrected exclusively by the Herbst appliance (age range before treatment: 11–13 years; mean duration of treatment: 12 months). **METHODS:** The moment arms of the masseter and temporal muscles as well as of the bite force and any relevant morphological characteristics were calculated from pre- and post-treatment lateral cephalograms taken in the natural head position in a standardized way. Fifteen cephalometric variables were used. The number and intensity (kg/mm^2) of occlusal contacts were evaluated by means of the photocclusion technique using memory-wafers. All cephalometric and photocclusion registrations were made without any appliance in the mouths of the patients. Paired *t*-tests were performed.

RESULTS: Significant improvements ($P < 0.001$) were found to the cephalometric variables corresponding to the moment arm of the masseter muscle and to the moment arms of the bite force when it was taken perpendicular to the mandibular plane and to the functional occlusal plane. Significant changes ($P < 0.05$) were also present in the ratios between the various mechanical advantages. However, following removal of the Herbst appliance both the number and intensity of occlusal contacts significantly decreased (-5.18 contacts, $P < 0.01$ and $-159.09 \text{ kg}/\text{mm}^2$, $P < 0.05$, respectively).

CONCLUSION: Dentofacial morphological changes after correction of Class II division 1 malocclusions by means of the Herbst appliance influence the moment arms of the masseter and temporal muscles. However, these changes are not associated with post-treatment improvement of occlusal contacts. Other factors, such as the dentoalveolar side-effects of treatment, occlusal settling or relapse following appliance removal and the need for continuation of treatment by means of fixed appliances, may be critical.

4 POSTERIOR MAXIMUM BITE FORCE VARIATIONS AND CRANIOFACIAL ARCHITECTURE IN YOUNG ADULTS

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AIMS: To evaluate posterior maximum bite force (MBF) in a group of healthy young adults and to test the correlations between MBF and the cephalometric configuration.

PATIENTS: Sixty-nine males and 49 females of the Euro-poid type aged 20–25 years with a good facial balance and good dental support. All the patients were healthy with no declared disease. None of them showed painful facial symptoms of either articular, muscular, dental or other origin.

METHOD: The method described by Ingervall (1986) was used to record bite force, with the same occlusal bite force recorder. MBF is given in Newtons. Males and females were treated separately. Ninety-nine known cephalometric variables were digitized. A principal component analysis reduced the number of representative variables to 28. Correlations between MBF and cephalometric variables were calculated. *P* value was set at 0.05.

RESULTS: In males MBF for the right side was 855.5, $\text{SD} = 223.7$ and for the left side 848.6, $\text{SD} = 201.5$. In females MBF for the right side was 707.7, $\text{SD} = 202.6$ and for the left side 710.5, $\text{SD} = 175.9$. MBF was significantly higher in males ($P < 0.00$). In neither group was there a significant difference for mean MBF at the right or left side. MBF did not correlate with height or weight in either males or females. No variation of MBF could be seen in subgroups of patients: 1. treated orthodontically, 2. with missing or extracted teeth ($n = 4$), 3. with endodontically treated teeth. In males MBF correlated with St-Go ($r = 0.24$, $P < 0.05$) ML/RL ($r = 0.23$, $P < 0.05$) and with variables describing the vertical relationships of hyoid bone with the neighbouring structures: hya-ML ($r = 0.29$, $P < 0.05$), hya-OL ($r = 0.29$, $P < 0.05$), hyaNSL ($r = 0.27$, $P < 0.05$). An almost significant correlation was seen for Cd-tGo ($r = 0.22$) and NSL-ML ($r = 0.22$). In females MBF correlated with posterior vertical dimension such as Cd-tGo ($r = 0.86$, $P < 0.05$), S-Go ($r = 0.43$, $P < 0.01$), with mandibular elongation Cd-Pgn ($r = 0.36$, $P < 0.05$), mandibular prognathism SNB ($r = 0.41$, $P < 0.01$), jaws discrepancy ANB ($r = 0.37$, $P < 0.01$), and with hyoid bone related variables such as hya-ML ($r = 0.36$, $P < 0.05$) and hya-CVT ($r = 0.37$, $P < 0.01$).

CONCLUSIONS: Under the conditions of the present investigation MBF showed an important inter-individual variability and was significantly higher in males than in females. MBF did not depend on height or weight. In both groups correlations were seen between MBF and variables representative of the vertical elongation of the face as well as with those involving the relationships of the hyoid bone with the neighbouring structures. The coefficients of correlation were weak, with a poor level of significance. This is probably due to the fact that MBF is actually a virtual concept. MBF refers rather to the aptitude of the muscles and the patient to develop heavy forces under arbitrary experimental conditions than to a representation of, for example, customary functional strain distribution on facial bones. An ideal experimental model for understanding the subtle relationships between bite force and facial morphology is still to be developed.

5 POST-TREATMENT CHANGES FOLLOWING THE USE OF A FACE MASK IN CHILDREN

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AIM: To evaluate the post-treatment changes occurring following the correction of Class III malocclusions with a Delaire face mask.

MATERIAL: Headfilms from 30 consecutive patients aged 4–8 years characterized by maxillary retrognathism who had their Class III relationship corrected with a face mask. The headfilms were taken before, immediately after, and a minimum of 2 years after therapy.

METHODS: The radiographs were digitized twice and changes in the growth pattern during and after treatment were compared. The impact of the original morphology and

the treatment changes on the post-treatment changes were analysed by a stepwise regression analysis.

RESULTS: During treatment the changes in the skeletal sagittal and vertical relationship were significantly correlated. After treatment there was a large variation from a complete skeletal relapse to a permanent change in the growth pattern. Among the parameters from the original morphology the inclination of the palatal plane, the occlusal plane, and the mandibular plane were inversely correlated with the long-term changes in sagittal relationship.

CONCLUSION: The prognosis for the early skeletal correction of Class III malocclusions with a face mask is dependent on the original vertical relationship. However, even in those subjects with a skeletal relapse, the dental relationship was maintained by dentoalveolar compensation.

6 TREATMENT OF LONG-FACE CHILDREN WITH AN OCCLUSAL SPLINT AND MUSCLE TRAINING

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AIM: To determine the skeletal and/or dental alterations in children with long-face syndrome.

SUBJECTS: Eighteen children in the growth period (mean age 9 years 4 months) with skeletal open bite and Class II skeletal characteristics were compared with a control group of 15 untreated children with same skeletal characteristics.

METHODS: The sample children were treated with a bonded upper occlusal acrylic splint and active masticatory muscle training with a special chewing gum for 1 year. Cephalograms were taken before and after treatment in the sample group and in the control group after 1 year. Paired *t*-tests were performed.

RESULTS: During the 1-year treatment period there was a significant decrease in inclination of the palatal and occlusal plane and a mean reduction of the mandibular angle NSL/ML of 2 degrees. The posterior facial height increased 1 mm and the anterior facial height 1.5 mm (mean values). There was a significant increase in overbite (3 mm on average), and of the angle SNB (1.5 degrees on average).

CONCLUSION: The combination of a bonded upper acrylic splint with simultaneous muscle training is an effective tool in controlling the vertical dimension in long-face children.

7 SONOGRAPHIC VISUALIZATION OF FOETAL CRANIOFACIAL STRUCTURES

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AIM: Two-dimensional (2D) sonographic imaging of the foetal craniofacial structures in the mid-sagittal plane, with respect to the prenatal jaw relationship

SUBJECTS: One hundred and sixty-four singleton healthy pregnant females between 9 and 38 weeks of gestation were

examined using a 2D external ultrasonic imaging device (Toshiba).

METHOD: Considering radiographic or histological diagnoses of the foetal jaw relationship, a 'primary embryonic mandibular prognathism' is said to be apparent between 8 and 12 weeks' gestation. To examine the *in vivo* growth pattern of the foetal jaw 164 healthy pregnancies were visualized between one and six times, providing non-invasive, high-quality images of the mid-sagittal plane. Each ultrasonic examination of the unborn resulted in multiple pictures, a total number of 89 imaging sessions took place between the 8th and 15th week, 42 sessions between weeks 16 and 20, 43 between weeks 21 and 25, 19 between weeks 26 and 30, and 29 between weeks 31 and 38 (gestational age was confirmed by measuring CRL and cranial circumference). Postnatal photographs were taken in 10 cases.

RESULTS: By establishing *x*- (mandibular and maxillary planes) and *y*-axes (perpendicular lines to *x*-axis through the most anterior point of the jaw bone) the mandible can be related to the maxilla in the sagittal plane. In the first group (gestation age 9–15 weeks) five foetuses with 'end-to-end' jaw configuration were found. In none of the five groups was mandibular prognathism observed. All measurements taken after 13 weeks' gestation showed mandibular retrognathism. A linear prenatal growth pattern seems to be apparent. Postnatal photographs demonstrate harmonic profiles with a slightly protruded upper lip and retrognathic gonion.

CONCLUSION: 2D sonography can enable visualization of the foetal craniofacial structures in the mid-sagittal plane. The results of this study showed five end-to-end configurations within the fourth month of gestation and a permanent retrognathic position of the mandible throughout the last 6 months. None of the ultrasounds showed any evidence of facial abnormalities, such as micrognathia.

8 EFFECTS OF DIFFERENT APPLIANCES IN SELECTED PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA

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AIMS: To investigate 1) the clinical efficacy of two types of oral appliances (OA), the Nocturnal Airway Patency Appliance (NAPA) + the Sleep Apnoea Elastic Reducer (SAER) and the QuietKnight (QK) in the short-term treatment of mild to moderate Obstructive Sleep Apnoea (OSA); 2) to assess the effect of this treatment with a follow-up evaluation and 3) to compare the effects of OA with a similar OSA group treated by Uvulo-Palato-Pharyngo-Plasty (UPPP).

SUBJECTS: Forty OSA patients (mean age 51.4 years, mean Body Mass Index 27.1, mean snoring history 14.4 years) were selected. These patients were divided into three groups (group 1: 10 NAPA + SAER patients; group 2: 10 QK patients; group 3: 20 UPPP patients). The subjects in groups 1 and 2 presented a retropositioned mandible (SNB 74.3 degrees), a

normal maxillary length (Ar-A 54.9 mm) and a PAS of 6.6 mm. The diagnostic nocturnal polysomnography indicated a mild to moderate OSA ($12 < \text{AM} < 40$), mean AHI 23.7.

METHODS: Two consecutive nights of MESAM 4 recordings were undertaken with the following protocol: 1) without OA (T_0) 2) after two (T_1) and four (T_2) months with AO for groups 1 and 2. Two MESAM 4 recordings for the UPPP group before and after surgery.

RESULTS: The results showed a significant improvement from T_0 (ODI 23.7, mean low SaO_2 90.2 per cent) to T_1 (ODI 20.7, mean low SaO_2 94.6 per cent) in 57 per cent of the patients for SaO_2 levels. These results were equal in groups 1 and 2, whereas the UPPP group had a 37 per cent success rate.

CONCLUSION: The OAs in the treatment of mild to moderate OSA are effective on OSA parameters. Thirty per cent of the patients were unable to tolerate the appliance and failed to co-operate. One reason for this may be that these patients are relatively sensitive to their problems and the OA requires improved stability in the mouth.

9 ORTHODONTIC AND ENVIRONMENTAL STIMULATION OF OSTEOBLASTS GENOME

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AIMS: Mechanical forces play an important role in the regulation and maintenance of alveolar bone phenotype during tooth movement in clinical orthodontics. However, other environmental influences such as muscular balance and respiratory function partly determine the stable positioning of teeth. In order to understand this equilibrium at the cellular level, the aim of this study was two-fold: 1) to examine the relationship between cellular 'environment' and osteoblasts and 2) to examine the effects of environmental (i.e. cellular adhesion) and orthodontic influences (i.e. mechanical forces) in the genomic regulation of osteoblasts.

MATERIAL: Seventeen-day-old embryonic chicken osteoblast cells.

METHODS: Cells were exposed to two forms of environments *in vitro*; a passive (cell ligation to its matrix) in fibronectin (1 mg/ml) and an active one (mechanical stimulation) with a device producing a homogeneous 1.3 per cent bi-axial uniform strain throughout the culture dish at 0.25 Hz during various time periods. Cells were incubated with RGD/RGE peptides and/or focal adhesion/receptor clustering drugs (LPA/BM), followed by RNA isolation and measurement of osteopontin (OPN) expression. OPN-constructs were transfected into osteoblasts prior to mechanical stimulation to localize specific DNA sequences (responsive elements).

RESULTS: Osteoblast response to both forms of influences demonstrated a distinct, but not mutually exclusive, set of signals. Subsequently, this study revealed that integrin receptors appear to be involved in mediating the signal transduction processes of both adhesion and mechanical

stimulation. In addition, manipulation of the OPN gene indicated that DNA sequences have the necessary information for the osteoblast response to mechanical forces. Finally, a hypothetical model on the genomic regulation of mechanical forces can be characterized by four distinct specificities: 1) matrix, 2) receptor, 3) signal transduction and 4) genomic (nucleus).

CONCLUSION: The combination of specific environmental (cellular adhesion) and orthodontic influences (mechanical forces) determined the genomic response of osteoblasts *in vitro*. The clinical significance of these results will be discussed.

10 THE INFORMATION PROCESS FOR THE ORTHODONTIC PATIENT

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AIMS: To study: a) the level of patients' and their parents' knowledge concerning orthodontics before the first consultation, b) how orthodontists meet the information requirements, and c) the type and quality of information available from various institutions.

SUBJECTS AND METHODS: Two hundred patients between 9 and 12 years of age and their parents were interviewed with respect to their existing knowledge and the need for information concerning orthodontics. In addition, 200 orthodontists were asked to fill in a questionnaire and to send in the pamphlets they used as a part of the information procedure. Several institutions were also asked to send in the information material they used. Part of this study was also the analysis of orthodontic books currently available for children.

RESULTS: Children were found to be very sensitive and critical as regards the aesthetic appearance of their teeth. Seventy-four per cent of them wanted to know more about the treatment methods, while 40 per cent were afraid of possible treatment and especially of fixed appliances and impressions. Despite their role as the main persons to be motivated, the young patients were not the main persons addressed at the first consultation. Only 3 per cent of the orthodontists exclusively addressed the children during the consultation, while 42 per cent of them only indirectly. The main means for informing the orthodontic patient was conversation, which was used regularly by 98 per cent of the orthodontists. However, only 51 per cent of the children answered that they preferred this as their primary source of information. Information material was mostly used in the waiting room. Objects, such as demonstration models, pamphlets and posters were used more frequently than sophisticated video computer presentations or slide shows. Books were not widely used, although they were highly rated by orthodontists, patients and parents.

CONCLUSIONS: It seems that there is a clear need to improve the information process for the orthodontic patient.

11 A NEW INTRAORAL ANCHORAGE DEVICE —THE MINI SCREW

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AIM: To develop a mini screw which can be used as intraoral anchorage for orthodontic tooth movements immediately after insertion.

MATERIAL: An 8 mm titanium screw with a diameter of 2 mm and a 'head' simulating a 0.022 × 0.028 inch bracket was produced.

METHODS: The stress strain distribution around eight possible locations tested on a dry skull was analysed by finite element analysis. The tissue reaction to immediate loading of screws in the infrazygomatic crest and the mandibular symphysis of *Macaca rhesus* monkeys was analysed after 1 and 2 months. Treatment using this procedure was finally carried out in 15 adult patients with no other intraoral anchorage possibilities.

RESULTS: The loading of the mini screws as simulated in the *in vitro* study led to local stress concentrations that explained the ischaemia and delayed resorption activity which contributed to the temporary stability. In addition, the histological examination revealed that small areas of osseointegration could be found. The reaction could be compared with that observed around intermediate implants or in relation to the screws used for distraction osteotomy. The clinical cases confirmed the usefulness of this type of anchorage.

CONCLUSION: A new intraoral anchorage system that is inexpensive, easy to use, and which can be loaded immediately, has been introduced.

12 RAPID PALATAL EXPANSION IN THE MIXED DENTITION: A CEPHALOMETRIC EVALUATION

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AIM: To evaluate skeletal and dental modifications induced by rapid palatal expansion (RPE).

SUBJECTS: Twenty patients in the mixed dentition with a mean age of 8 years. All subjects had a maxillary transverse deficiency with a uni- or bilateral crossbite of the posterior teeth.

METHODS: The alterations caused by the RPE were assessed on two lateral cephalometric radiographs (T0-T1), the first taken before any activation and the second after the active phase of expansion. The time span between these two cephalometric films ranged from 8–10 days. The cephalometric measurements used were: SNA, SNB, ANB, AO-BO, point A and Pg to Nasion perpendicular, PTM-A, FMA, SN-GoGn, bispinal-GoGn, bispinal-SN, Ar-Go, bispinal-Me, SN-PNS, SN-ANS, GoMe-PNS, GoMe-ANS, S-Go, N-Me, IMPA, I/FH, interincisor angle and the Biggerstaff molar index. To identify the effects of rapid palatal expansion, the subjects

were compared with untreated groups. Statistical data analysis included non-parametric Wilcoxon's test and Pearson's correlation coefficient for associations between variables.

RESULTS: The maxilla displayed a tendency to rotate downwards and backwards as did the palatal plane, resulting in an increase of bispinal-SN and SN-ANS. The anterior face height (N-Me) also increased and a significant correlation was found between it and the dental molar measurement which also increased.

CONCLUSION: RPE results in skeletal and dentoalveolar changes in the maxilla.

13 SPONTANEOUS PERMANENT MOLAR EXPANSION IN CROSSBITE AND NON-CROSSBITE PATIENTS

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AIM: To evaluate spontaneous expansion and stability of first permanent molars after use of a rapid palatal expansion (RPE) appliance during the deciduous dentition in crossbite and non-crossbite patients.

SUBJECTS AND METHOD: An RPE appliance was cemented on the second deciduous molars and canines in 19 (13 F and 6 M) patients with lateral permanent molar crossbite (Group A) and in 13 (10 F and 3 M) patients with non-lateral crossbites (Group B). After a mean appliance activation time period of 15 days and a range appliance activation from 4–8 mm, the appliance was blocked and kept in place as retention for 5–10 months. Neither active nor passive retention was applied on the first permanent molars. Impressions of the dental arches were taken before insertion of the appliance (T1), when the appliance was blocked (T2), and at time of debanding (5–10 months later) (T3). Measurements of the first permanent molar width were registered at T1, T2, and T3.

RESULTS: The mean maxillary intermolar width (6-6) was in group A: 40.6 at T1, 46.0 at T2, and 46.3 at T3; in group B: 42.4 at T1, 46.3 at T2, and 45.4 at T3. In all subjects the transverse intermolar width increased during the active phase of expansion, and in Group A the crossbite was corrected and the correction was spontaneously maintained.

CONCLUSION: In these patients, active transverse forces used during the deciduous dentition, produced spontaneous expansion of the first permanent molars. During fixed retention of the deciduous dentition the expansion of the intermolar width was spontaneously maintained in the crossbite group.

14 QUALITATIVE AND QUANTITATIVE MICRO-COMPUTER TOMOGRAPHIC ASSESSMENT OF BONE REGENERATION IN RAT CALVARIAL DEFECTS

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AIM: To assess the quality and quantity of newly formed bone in calvarial defects in rats systemically injected with growth hormone (GH) by means of micro-computer tomographic (CT) scanning.

MATERIALS AND METHOD: Forty 1-year-old Wistar rats were used in the study. Two full-thickness bone defects, 5 mm in diameter, were trephined in the dorsal part of the parietal bone, lateral to the sagittal suture. The bone defects were covered with an exocranial expanded polytetrafluoroethylene membrane (Gore-Tex) placed between the periosteum and the parietal bone, and an endocranial membrane placed between the dura mater and the parietal bone. Twenty rats were injected subcutaneously with recombinant human GH (2.7 mg/kg/day) dissolved in sterile water (1.35 mg/ml), whereas the remaining 20 rats were injected subcutaneously with isotonic sodium chloride (0.5 ml/12 hours). The animals were killed 28 days after surgery. From each animal the left defect was scanned using a micro-CT scan (μ CT 20, Scanco Medical) with a resolution of 30 μ m. Three-dimensional reconstructions were made and the amount of bone in these reconstructions was calculated. Furthermore, the amount of bone falling within fixed grey-value ranges was also measured, resulting in histogram-like frequency distributions of which the median and quartiles were determined.

RESULTS: The GH group had considerably higher bone volumes (range: 4.3–7.8 mm³) than the control group (range: 1.6–6.1 mm³). Both the median and quartiles of the grey-value histograms in the GH group were lower than the control group, suggesting that the GH group had relatively less mineralized bone.

CONCLUSIONS: Micro-CT scanning is a useful tool in the qualitative and quantitative assessment of bone regeneration. In this particular study it has been shown that GH administration produces more bone volume in rat calvarial defects, but this newly formed bone is less mineralized than in the untreated group.

15 VERTICAL CONTROL OF HIGH ANGLE PATIENTS WITH A MODIFIED TRANSPALATAL ARCH

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AIM: To determine the skeletal and dental effects of a modified transpalatal arch for controlling the vertical dimension in high angle patients.

SUBJECTS: Two matched groups each containing 16 high angle patients.

METHOD: Group I, with a pre-treatment mean age of 13.4 ± 1.6 years, were treated with extraction of four first premolars in conjunction with a vertical holding appliance (VHA) cemented in place for 17.4 ± 6.1 months. Group II, with a mean pre-treatment age of 13.4 ± 1.9 years, were also treated by extraction of four first premolars followed by standard edgewise treatment. The measurements taken on the pre- and post-treatment cephalometric radiographs were compared.

RESULTS: In Group I, FMA and GoGn-SN angles decreased, while both of these measurements increased in Group II. The y-axis angle increased ($P < 0.05$) and the lower anterior face height increased significantly in Group II ($P < 0.05$). The percentage of lower anterior face height to total anterior face height decreased significantly in Group I compared with Group II ($P < 0.01$). Extrusion of the maxillary first molars was less in Group I than in Group II.

CONCLUSION: The VHA can be an effective adjunct in controlling the extrusion of maxillary molars in patients with vertical growth patterns.

16 HISTOLOGIC AND RADIOGRAPHIC INVESTIGATION OF LOADED AND UNLOADED IMPLANTS

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AIM: To analyse radiographically and histologically the bone-implant contact and bone surface area of loaded and unloaded implants.

MATERIAL AND METHOD: Twenty-nine Brånemark implants were placed in the zygomatic arch of five dogs. After a healing period, 20 implants (four in each dog) were loaded during 8 weeks with an excessive non-axial orthopaedic force application of 5 N. This force pushed between the implants and a maxillary splint to move the maxilla forwards. Nine implants were unloaded during this period. At the end of the experiment the 29 implants were retrieved to carry out radiographic as well as histologic analysis. Histomorphometry was performed with a Leitz light microscope and a Leitz Microvid. Direct bone-implant contact and bone surface area inside the threads of the implants were measured. *t*-tests were performed.

RESULTS: The radiographic and histologic analyses showed bone with a normal trabecular pattern around all the implants, although 100 per cent bone contact was not observed. There was no significant difference in direct bone-to-implant contact and bone surface area between the loaded and unloaded implants; neither was there a significant difference between the tension and compression side of the loaded implants.

CONCLUSION: Titanium implants can be used as anchorage for orthopaedic force application systems.

17 A NEW LOOK AT CRANIOFACIAL GROWTH: THE CRANEXPLO

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AIM: To explore cranial morphology before orthodontic treatment.

SUBJECTS: One hundred and forty-one patients and 47 children with only their first permanent molar erupted.

METHODS: A new exploration of the cranial skeleton was undertaken within an odontogenic perspective by

attempting to understand the systems' growth 'dynamics'. Conventional telerradiographs with the addition of two cross-exocranial measurements were used. Four organizational planes (spheno-ethmoidofrontal, spheno-occipital, occipito-pterygoid, fronto-temporal) were selected. Statistical analysis showed the cranial specificities and the distribution of malocclusions.

RESULTS: A cranium-face relationship was found. Occlusal disorders have an upper basicranial origin and do not appear at random. The present research was based on the inner determinants responsible for the modalities of flexion of the basicranium. This odontogenic phenomenon has numerous evolutionary trajectories; these individual trajectories have their own properties and interact on occlusal excursions. The eruption of the first permanent molar is not a trivial event.

CONCLUSION: Dentofacial disharmonies are the result of destabilization in the assembly of the mosaics of the basicranium. Further research is being carried out towards cephalometrics before the age of 6 years, which will then predict growth.

18 COMPARISON OF CONDYLAR PATHS AND ARTICULATOR GENERATED VERTICAL GROWTH ARREST CAUSED BY DENTAL IMPLANTS REPLACING UPPER ANTERIOR TEETH

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AIM: Demonstration of vertical growth arrest of the maxilla by implants replacing anterior teeth in growing individuals.

SUBJECTS: Longitudinal data of two individuals with implants replacing a lost central incisor at age 10 and 11.5 years respectively, in combination with data from the Groningen longitudinal growth study on orthodontically untreated individuals.

METHODS: Vertical development of face height was compared cephalometrically with the Groningen study and depicted graphically.

RESULTS: Both individuals with implants showed a significant arrest in vertical drift of the upper dentition and concurrently a deficit in resorptive lowering of the nasal floor as compared with the vertical growth of the untreated sample.

CONCLUSIONS: Replacement of a single tooth by an immovable implant in growing children will have detrimental local and regional effects. Locally, interruption of vertical alveolar bone growth adjacent to implants will lead to deep bony defects. Regionally, the introduction of a rigid element compromises vertical facial development. The arrest of vertical drift of the dentition and the concomitant arrest of lowering resorption of the nasal floor was an unanticipated finding as a more or less normal caudal relocation of the palate, eventually leading to a situation in which the implant penetrated the floor of the nose, was expected. As a result of these findings it is recommended that the introduction of dental implants should be postponed until growth has ceased.

19 FOETAL CEPHALOMETRY IN THREE-DIMENSIONAL ULTRASOUND IMAGES OF CRANIOFACIAL DEFORMITIES

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AIM: Three-dimensional (3D) ultrasound enables diagnosis of craniofacial deformities at an early stage of pregnancy. To the present this has been based on clinical impression and experience of the examiner. This study aimed to evaluate the basis to apply orthodontic cephalometric knowledge for improvement and study of 3D sonographic findings.

SUBJECTS: Six hundred and eighteen foetuses were scanned as part of the routine assessment for exclusion of physical defects in a conventional way as well as in a 3D procedure between the 9th and 37th week of gestation. There were two different ways of obtaining 3D images during pregnancy: intra-vaginal scanning (5 MHz), leading to improved imaging in gestations of up to 15 weeks, and transabdominal ultrasound at a more advanced stage of conception (3.5 MHz). One hundred and twenty-five foetuses were assessed to determine whether a correct mid-sagittal position for cephalometry could be achieved by simple visual adjustment of the 2D ultrasound scans. The results were compared with a specific plane determination, which is possible after processing of 3D data in an orthogonal display.

RESULTS: 3D processing leads to improvement and facilitates diagnosis of craniofacial deformities. The spatial depictions resulted in five findings in addition to the 20 defects detected by conventional sonography. Although facial features could be obtained from the 9th week of gestation onwards, high quality images were yielded by 20 weeks. Subjective imaging with 2D sonography in the mid-sagittal position in 30.4 per cent led to deviations of up to 20 degrees in one or two planes with distortion of the structures to be assessed. With spatial 3D positioning these false appraisals were almost eliminated.

CONCLUSION: 3D sonography is a valuable technique for improved presentation and detection of craniofacial deformities. By post-processing the specific mid-sagittal planes can be presented from the 3D sonographic data set.

20 HISTOLOGIC EVALUATION OF ENDOSTEAL PALATAL IMPLANTS AFTER ORTHODONTIC LOADING

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AIM: Presentation of histologic evaluation of endosteal palatal implants after orthodontic loading.

MATERIAL AND METHOD: Twenty palatal implants were evaluated histologically and electron-microscopically following explantation. Before explantation the transmucosal step-cylinder implants were temporarily loaded for orthodontic anchorage. Three implants were lost in the unloaded

healing period and one implant at the end of the orthodontic anchorage-period. Two unloaded implants were studied as the control and the remainder were investigated clinically and with regard to maxillary insertion (position, inclination, etc.).

RESULTS: The results showed, according to axial implant loading or dental distal fixation of the transpalatal implant arch, the best bone to implant contact with the surface. An interesting observation was of clinically sufficient anchorage stability and histological existence of connective tissue partly around the implant surface with as wide as possible distal dental fixation of the implant fixated transpalatal arch. Especially in cases with distalization of molars (Class II occlusion, loaded with more than 200 g) typical signs of remodelling were observed.

DISCUSSION: The histologically investigated palatal implants underline the biomechanical evaluations of axial implant loading with distal dental fixation of the transpalatal arch. Previous investigations concerning unproblematic osseointegration of palatal implants without any biomechanical criteria could not be confirmed in this study.

21 COMPUTER TOMOGRAPHIC SCANS REVEAL INCISOR RESORPTION AFTER ECTOPIC ERUPTION OF MAXILLARY CANINES

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AIM: To study incisor resorption with different radiographic methods, including computed tomography (CT) scans.

SUBJECTS: In 107 consecutive patients with ectopically erupting canines, mean age 12.9 ± 2.5 years, 159 ectopic maxillary canines were found. Fifteen per cent were buccal and 36 per cent of the individuals were male. The canine-incisor relationship was assessed with different radiographic methods including CT. CT scans were obtained with a Siemens Somatome plus CT-scanner set at 3,000 Hounsfield. Forty-six variables were measured. Statistical analysis was performed according to the SPSS-program. Sixteen lateral incisors were extracted and confirmed the radiographic diagnosis.

RESULTS: Altogether 61 lateral incisors and 14 centrals showed resorption. Two-thirds of the resorption extended into the pulp in these young individuals. The earlier report, based on tomograms, that 12 per cent of ectopic canines resorb is thus revised (Ericson and Kurol, 1987). No association with agenesis of laterals (7 in 5 individuals), peg-shaped laterals or other tooth developmental disturbances was found. The dental follicle size was not different in normal and ectopic sides.

CONCLUSION: Incisor resorption is common (34 per cent) in young individuals in association with ectopic maxillary canines, and two-thirds of the resorption extends into the pulp. The resorption is reliably revealed by CT. Follicular form and width have no association with resorption.

Ericson S, Kurol J 1987 Radiographic examination of ectopically erupting maxillary canines. *American Journal of Orthodontics and Dentofacial Orthopedics* 91: 483–492

22 INVESTIGATION OF BACTERAEMIA FOLLOWING ORTHODONTIC DEBANDING AND DEBONDING

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AIM: To investigate the incidence of bacteraemia following orthodontic debanding and debonding.

SUBJECTS: Thirty patients (10 males, 20 females) aged 18.5–29 years of age (average 22.5 years). All were treated using the Edgewise technique. Patients who had fixed appliances in both jaws were included in the study.

METHOD: Blood samples were obtained from the ante-cubital vein before the removal of bands and brackets and 2 minutes after completion of the debanding and debonding procedure. Ten millilitres of blood were aseptically inoculated in two blood culture bottles that were then connected with a growth indicator device and incubated at 37°C for 14 days. Cultures were taken from positive bottles and plated on both blood agar and blood agar supplemented with 0.0005 per cent hemin and 0.00005 per cent menadione under aerobic and anaerobic conditions. Bacterial colonies were counted, identified by colony morphology, gram staining, standard microbiological biochemical testing technique, pure plate technique and API 20 streps.

RESULTS: Bacteraemia was detected in the pre-operative blood samples of two subjects (6.6 per cent) and post-operative blood samples of two other patients (6.6 per cent). *S. Salivarius* (3 CFU/ml) and *S. Sanguis* II-2 (8 CFU/ml) were identified in the pre-operative blood samples and *S. Sanguis* II-2 (12 CFU/ml) and *S. Mitis* I (6 CFU/ml) in the post-operative blood samples.

CONCLUSION: Bacteraemia was detected in 6.6 per cent of both pre- and post-operative blood samples. Until more data is available on this subject, the orthodontist is advised to seek guidance from the patient's cardiologist before commencing orthodontic treatment in individuals at risk of bacterial endocarditis.

23 TREATMENT AND POST-TREATMENT CHANGES INDUCED BY ORTHOPAEDIC CLASS III TREATMENT

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AIM: To evaluate treatment and post-treatment dento-skeletal changes in Class III subjects treated with a rapid maxillary expander and face mask.

SUBJECTS: The treated sample (29 subjects) was divided into two groups according to the stage of dental development. The mean age in the early-treated group (16 subjects

in the early mixed dentition) was 7 years \pm 7 months at T1 (before treatment), 7 years 9 months \pm 8 months at T2 (end of treatment), 8 years 10 months \pm 11 months at T3 (post-treatment). The mean age in the late-treated group (13 subjects in the late mixed dentition) was 8 years 8 months \pm 1 year at T1, 9 years 7 months \pm 11 months at T2, 10 years 9 months \pm 11 months at T3. Matched control groups of subjects with untreated Class III malocclusions were selected for both early- and late-treated groups at both observation intervals (T1–T2, T2–T3).

METHODS: Computerized cephalometric analysis at all time periods comprised measurements for the evaluation of sagittal and vertical skeletal relationships, dentoalveolar relationships, inclination of the mandibular condyle, and mandibular length. Dentoskeletal changes from T1 to T2 (treatment changes) and from T2 to T3 (post-treatment changes) in both early- and late-treated groups were compared with changes in corresponding control groups by means of non-parametric statistics (Mann-Whitney *U* test).

RESULTS: Orthopaedic therapy produced a significant skeletal maxillary advancement only in the early-treated group. Significantly reduced increments in mandibular length in association with a significant upward-forward direction of condylar growth were found in both early- and late-treated groups. During the post-treatment period both maxillary and mandibular growth rates did not show any significant difference between treated and control groups.

CONCLUSIONS: A Class III growth pattern is re-established in the post-treatment period both in early- and late-treated subjects. The correction of Class III malocclusions therefore depends upon the amount of favourable change during active treatment. As only early treatment provides significant enhancement of maxillary growth, the early mixed dentition is the optimum treatment timing for Class III malocclusions.

24 KINEMATOGRAPHIC MAGNETIC RESONANCE IMAGING: A NEW TOOL IN THE DIAGNOSIS OF OPEN BITE

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AIM: To visualize deglutition in anterior open bite patients, before and after orthodontic treatment.

SUBJECTS: Six patients (three male, three female) between 7 and 12 years of age exhibiting an anterior open bite.

METHODS: All patients underwent a kinematographic magnetic resonance examination before orthodontic treatment (*T*₁). This investigation was performed with a 2D TSE sequence in the median sagittal plane (head-neck coil, matrix 265 TR 500, TE 74, thickness 10 mm). Fifty-five temporal consecutive (video) images were acquired within 29 seconds. Therapy was conducted using removable and fixed appliances. Some patients had adjunct logopedic treatment, while others had palatal spurs in order to break their swallowing habit. After 1.5 years (*T*₂) the open bite was corrected to a

regular anterior tooth relationship and the altered tongue movement during deglutition was recorded by means of kinematographic magnetic resonance imaging.

RESULTS: It could be shown that the tongue position changed during therapy. While the time-span of swallowing remained unchanged, the contact time between the tongue and the anterior teeth was either reduced, or the tongue no longer pressed against the palatal surface of the anterior teeth. In this small sample no differences between the therapy methods (fixed versus removable appliances) were found.

CONCLUSION: Kinematographic magnetic resonance imaging is an impressive method to visualize tongue movements during deglutition.

25 THREE-DIMENSIONAL COMPUTED TOMOGRAPHY IN ORTHODONTICS

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KEYNOTE ADDRESS

AIM: Integration of computed tomography (CT) HR-CT and three-dimensional (3D) methods in orthodontic, orthopaedic and orthognathic diagnosis, treatment planning and treatment control.

SUBJECTS, MATERIAL AND METHOD: *In vitro*: 27 human specimens and one dry skull. *In vivo*: 150 patients.

RESULTS:

1. HR-CT scanning offers imaging of the dentate alveolar process topography and the buccal and lingual bone plates true to scale without overlying structures in contiguous scans of defined thickness. Periodontal lesions such as bone dehiscences or fenestrations, lateral root resorption, bony pockets and furcation involvement could be identified and measured.

2. HR-CT scanning before, during and after orthodontic treatment allows 3D interpretation of periodontal lesions and remodelling, especially the development and repair of orthodontically induced bone dehiscences in relation to the initial periodontal situation, the orthodontic treatment concept and applied biomechanics.

3. After axial CT-scanning the data sets are transferred to a commonly used computing system (IBM) to reconstruct 3D images. After definition of measurement points various measurement tools permitted a 3D cephalometric analysis on the monitor. The degree of asymmetry of the skull and skin morphology could be evaluated with different measurement procedures. 3D cephalometry with a personal computer and user-specified software permits a high degree of flexibility. 3D cephalometry is at present indicated only in patients with severe craniofacial deformities.

4. After the transfer of CT-data to life-size 3D skull models and replacement of imprecise dental arches by dental casts, different orthodontic and surgical treatment concepts could be evaluated. The orthodontic set-up and 3D model surgery permit a verification of the feasibility of the most suitable mobilization and placement of bone segments. The clinical treatment sequences indicated that the integration of 3D

cephalometry and 3D model surgery in patients with severe asymmetric craniofacial deformities allowed a higher precision of diagnosis and treatment planning.

5. Present and future research will deal with computer-aided 3D visualization of orthodontic treatment concepts.

26 ANTERIOR MANDIBULAR POSITIONING AND MINIMUM PHARYNGEAL CROSS-SECTIONAL AREA

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AIM: To evaluate the effect of an anterior positioning appliance (AMPA) on minimum pharyngeal cross-sectional area (MPCSA). Anteroposterior and lateral pharyngeal dimensions were also measured.

SUBJECTS: Thirty-two conscious supine obstructive sleep apnoea (OSA) subjects.

METHODS: The change in MPCSA and linear pharyngeal dimensions were measured using low dose computerized tomography with and without an AMPA *in situ*.

RESULTS: The mean presenting apnoea/hypopnoea index (A/HI) was 26.6, with a body mass index of 28.01 Kg/m². There was a statistically significant ($P=0.011$) increase of MPCSA of 28.34 mm² on appliance insertion (s.d. = 59.01 mm²; range -145 to +190 mm²; $P=0.011$). The mean mandibular displacement was 5.73 mm (s.d. 2.514 mm) in protrusion and 8.27 mm (s.d. 4.510 mm) inferiorly. Reproducibility analysis, calculated from re-measuring 10 subjects, indicated a limit of agreement for MPCSA of -7.3 to +7.1 mm², and a Pearson's correlation coefficient of 0.994. There was poor correlation between the amount of mandibular displacement and change in MPCSA (protrusion $r=0.268$; inferiorly $r=0.240$). The lateral pharyngeal dimension increased by more than twice that of the anteroposterior expansion.

CONCLUSION: The AMPA significantly increased MPCSA in OSA subjects, suggesting that the AMPA may be an effective therapy for OSA subjects. Lateral pharyngeal dimensions increased by twice that of the anteroposterior enlargement. There was, however, a wide individual variation of response, which was multifactorial and requires further investigation.

27 HARD PALATE DEFORMATION IN RESPONSE TO A QUASI-STATIC LOAD ON ENDOSTEAL IMPLANTS IN DIFFERENT AGED PIGLETS

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AIM: To identify sufficient anchorage for dental fixation in young patients. In an animal model the deformation of the

palate in pigs by acute quasi-static loading was investigated. **MATERIAL:** Three series of tests (with new-born, young and adult pigs) were performed, each with two groups (2 treatments: 1- or 2-point-stress) and seven animals per group. **METHODS:** The load was applied with either a 1- or 2-point method. Endosteal implants (discs) with a diameter of 9.2 and 5.3 mm in the first group were placed in the suture area. The discs in the second group were placed at both the right and left side of the suture (new method with two implants). The pressure stress (of one or both discs) was applied from a pressure screw, vertical to the palatal surface. This device allowed a precise force application.

RESULTS: The 1-implant method failed in young animals, where measurements showed an instability in the area of the suture with final fracture, whereas the 2-implant method gave stable results (without fracture). In contrast, adult pigs showed stable results with both methods. In general a larger diameter of disc leads to less instability. In adult animals the 1-implant method seems to be suitable, whereas during ossification a 2-implant method might be favourable.

CONCLUSION: With new-born animals slight stress led to deformation of the surfaces associated with irreversible changes, in the case of the 1-implant method. The suture of new-born animals is not yet ossified and consists of collagenous fibres. The advantages of the 2-implant method are improved control of the dental fixation and less palatal damage.

28 CLASS II MALOCCLUSION: COMPARISON OF ALTERNATIVE TREATMENTS AND TIME OF TREATMENT

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KEYNOTE ADDRESS

AIMS: To evaluate the early treatment of Class II division 1 malocclusions in prepubertal children. The specific aims included the analysis of differences between two modalities of treatment, namely the headgear and the Fränkel function regulator, and the evaluation of timing of treatment.

SUBJECTS: From an original number of 84 children recruited in a prospective randomized clinical trial, 63 were included in the study for the planned period of treatment (2 years). The children's ages ranged from 7.2 to 13.3 years (skeletal ages: 5.75 and 13.75 years, respectively).

METHODS: Lateral cephalographs were taken following a standardized method at baseline and after 1 and 2 years. Molar and canine relationships, overjet, intermolar and intercanine distances were measured from casts made every 2 months, and mounted on a SAM II articulator. Where applicable, the statistical methods included *t*-tests, analyses of variance and covariance and regression analysis.

RESULTS: Both the headgear and function regulator were effective in correcting the malocclusion. A common mode of action of these appliances is the possibility to enhance differential growth between the jaws. The extent and nature of this effect, as well as other skeletal and occlusal responses,

differed. Treatment in late childhood was as effective as in mid-childhood.

CONCLUSION: On average treatment outcome was the result of the cumulative effects of small to moderate changes within the skeletal and dentoalveolar components, rather than a major change in either or both of these components. The difference in outcome between appliances is defined as the sum of these changes. Timing of treatment may be optimal in the late mixed dentition, thus avoiding a retention phase prior to a later stage of orthodontic treatment with fixed appliances. However, a number of conditions may dictate an earlier intervention in the individual patient.

29 THE PENDULUM APPLIANCE IN CLASS II THERAPY

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AIM: To evaluate the dental effects of the Pendulum appliance in Class II non-compliance therapy.

MATERIAL AND METHODS: The Pendulum appliance consists of an anterior acrylic Nance button in the palate for anchorage and two posteriorly extending 0.32 TMA springs that deliver a light, continuous force to the upper first molars without affecting the palatal button. The appliance produces a broad, swinging arc or pendulum of force from the midline of the palate to the upper molars. The sample group comprised 15 patients (7 males, 8 females), mean age 14.8 years, with a Class II molar relationship. In eight patients the second molars were fully erupted (group I), in seven patients the second molars were unerupted (group II). Measurements were obtained from cephalometric, periapical and panoramic radiographs after 3 months (T1), 6 months (T2) and 8 months (T3) of therapy. The patients were seen every 4 weeks to monitor the spring pressure and to reactivate if necessary.

RESULTS: An increase of the space between the molar and premolar of 2 ± 2 mm (group I) and 3 ± 1 mm (group II) was found at T1. An increase of 1 ± 1 mm (group I) and 2 ± 1 mm (group II) at T2, and 1 ± 1 mm (group I) and 3 ± 1 mm (group II) at T3 was observed. The space created was due to molar bodily translation. A loss of anchorage (3 ± 1 mm) was also noted due to first premolar mesialization.

CONCLUSIONS: Distal movement of the molars appears to be most efficient before the upper second molars have erupted. However the molars will still move even if the second molars have fully erupted. Patient tolerance of the Pendulum appliance is excellent. These results are encouraging for Class II non-compliance therapy.

30 ACCURACY OF DIGITAL IMAGING AND FUTURISTIC TECHNOLOGY

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KEYNOTE ADDRESS

Digital imaging is one of the newest technologies to influence orthodontics. Potential benefits of imaging could include:

clearer communication with patients, better data manipulation, improved treatment planning, and enhanced interfacing with collaboration specialists.

RESEARCH STUDIES:

1. Predicting soft tissue changes in mandibular advancement surgery. It has been concluded that (a) the upper lip and chin areas were the most accurately predicted; (b) the lower lip appeared to be the least predictable,
2. Predicting soft tissue changes in maxillary impaction surgery. Similar findings have been recorded: (a) maxillary soft tissue predictions were reasonably accurate; (b) the software algorithms had particular difficulty in predicting lower lip change subsequent to surgery.
3. The accuracy in predicting growth and treatment changes through imaging. It has been reported that (a) predicting growth and treatment changes in the pre-adolescent patient were acceptable; (b) not very accurate in predicting changes in adolescent subjects.
4. The role of computerized video imaging in predicting adult extraction suggests (a) support for the accuracy of soft tissue predictions when primarily dental rather than skeletal changes are made; (b) lay people felt the video images were representative of the actual post-treatment outcomes rating them good to excellent, while the orthodontists were more critical judging the predicted images as being fair to good; (c) the upper lip showed a relatively consistent 58 per cent hard to soft tissue retraction ratio similar to other studies, while the lower lip's variable retraction averaged 120 per cent of the underlying hard tissue change.

CONCLUSIONS: The emergence of digital imaging represents: 1. The logical conclusions to the line of development of visual treatment objects (VTOs) by providing the most realistic representation to-date of a patient's probable outcome. 2. A means to address what is for many patients their chief concern, the aesthetic appearance of their face and teeth, thereby facilitating the decision as to whether to undergo treatment or not. 3. A means by which the orthodontist and the oral and maxillofacial surgeon are able to assess different treatment alternatives and make the most appropriate treatment planning decision. 4. A means by which communication can be facilitated between different professional specialties as well as between professionals and patients to ensure that all expectations are addressed and that there is full consent and agreement as to the goals of treatment.

31 EVALUATION OF POST-TREATMENT ROOT RESORPTION IN OPEN BITE SUBJECTS

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AIM: To compare the occurrence and severity of root resorption in open bite subjects treated with fixed or functional-orthopaedic appliances (FOA).

SUBJECTS AND METHOD: Seventy-three open bite patients (55 girls and 18 boys) treated with fixed or FOA. The material comprised 34 and 39 pairs of panoramic radiographs

of fixed and FOA treatment groups, respectively. The mean duration of treatment was 29 months for the fixed therapy and 17 months for the FOA group. The anterior region (i.e. central and lateral incisors and canines) of both arches were evaluated at pre- and post-treatment stages by using the modified rating system proposed by Sharpe *et al.* (1987). Root development, root shape and existence of root canal therapy were also examined in all of the subjects.

RESULTS: In the FOA group, the average percentage root resorption for maxillary and mandibular anterior teeth was 3 and 13 per cent, respectively. However, in the fixed appliance treatment group, the average amount of root resorption was 36 per cent for the maxillary and 45 per cent for the mandibular teeth. In the FOA group, no tooth had resorption of more than one-third of its total root length (score 3). However, in fixed appliance treatment group 14 per cent of the maxillary and 2 per cent of the mandibular anterior teeth were scored as 3.

CONCLUSION: The findings of the study indicate that open bite patients treated with fixed appliance therapy exhibit more root resorption compared with those treated with FOA.

32 EXPRESSION OF COLLAGEN mRNA AND ALVEOLAR BONE FORMATION AFTER ORTHODONTIC TOOTH MOVEMENT AND TOOTH EXTRACTION OF RAT MOLARS

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AIM: To compare the initial state of bone formation on the tension side in the periodontal ligament (PDL) from orthodontic forces with that after tooth extraction in the alveolar socket.

MATERIAL: Histological sections of the upper first molars and extraction alveolar sockets from 12 female Sprague-Dawley rats.

METHODS: Two groups of six rats each were treated parallel. The first group was given a fixed orthodontic appliance at day 1, which delivered a parallel palatal force of 150 mN to the upper first molars. The second group had the upper first molars extracted at day 1. Two animals from each group were sacrificed at days 3, 7 and 14, respectively. The maxillae were prepared for histological examination with the sections cut parallel to the mesial root of the upper first molar and in a similar region of the extraction alveolar socket. The sections were prepared for haematoxylin-eosin staining and *in situ* hybridization for expression of collagen Type I.

RESULTS: The expression of collagen Type I was detectable at day 3 on the tension side of the PDL in the orthodontic group and on the palatal side in the alveolar socket in the extraction group. The expression reached its maximum at day 7. The haematoxylin-eosin stained sections showed, on the tension side, newly formed bone along the stretched collagen fibres. No synthesis of collagen could be noticed on

the pressure side or towards the acellular cementum on the root on the tension side, contrary to the cellular cementum. The alveolar bone socket was disorganized and filled with newly formed bone approaching from the buccal and palatal sides.

CONCLUSION: When comparing the orthodontic tooth movement group with the extraction group with emphasis on expression of Type I collagen, the synthesis seemed to start at the same time, but the localization of the cells showing high expression differed between the groups.

33 THREE-DIMENSIONAL SHAPE DESCRIPTION OF THE MAXILLARY ARCH

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AIM: To develop and validate a time- and cost-effective method for quantitative three-dimensional (3D) analysis of the maxillary alveolar arch in children with cleft lip and palate regardless of the presence or absence of teeth.

MATERIAL: The material consisted of maxillary plaster casts from 10 children with complete unilateral cleft lip and palate (UCLP) at 6 weeks and 9 years of age, respectively.

METHODS: The plaster casts were all scanned in a Siemens Plus 4S CT-scanner with 1 mm slice thickness, and slices reconstructed at every 0.1 mm. 3D computer models were generated by use of the software Analyze™ and anatomical landmarks were digitized on these models directly on the screen. 3D spline curves were fitted to the data, consisting of the following reference points: Frenulum, SilmannIV, and the alveolar endpoints, in addition to 15 guiding points along the alveolar arch. A number of variables were calculated. The error of the method, $s(i)$, was determined by duplicate measurements on 10 different models. The intra- and inter-observer error, E , was determined by repeated digitization ($n = 20$), both on models with and without teeth.

RESULTS: The error of the method $s(i)$: 0.30 (range: 0.11–0.90) mm for landmarks, 0.87 (range: 0.29–1.48) mm for linear variables, and 1.5 degrees for angular variables. The average value of E (1 standard deviation) was 0.26 (range: 0.04–0.45) mm for landmarks, 0.89 (range: 0.25–2.14) mm for linear variables, and 2.27 degrees for angular variables, irrespective of the presence or absence of teeth.

CONCLUSION: CT-scanning of plaster casts followed by computer reconstruction and 3D digitization has been shown to be a reliable cost- and time-efficient quantitative method for describing the shape of the maxillary alveolar arch regardless of the presence or absence of teeth.

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34 CALLUS DISTRACTION OF THE HYPOPLASTIC AND ATROPHIC MIDFACE—PLANNING AND PROCEDURE

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AIM: The correction of sagittal discrepancies in severely atrophied or hypoplastic maxillae has proven to be difficult and resulted in a multitude of approaches. Callus distraction of the whole midface offers a new interdisciplinary treatment and its use will be discussed.

METHODS: Five patients (3 of them edentulous: e.g. a 35-year-old female, bilateral cleft lip and palate, edentulous upper jaw and extremely atrophied maxilla, velopharyngeal flap; two dentate patients: an 18-year-old female, midfacial hypoplasia, multiple aplasia of maxillary teeth; a 16-year-old male, bilateral cleft lip and palate, retropositioned-hypoplastic maxilla, velopharyngeal flap) were treated with a halo-frame fixed distraction device (RED, Fa. KLS Martin). Sagittal and vertical movements were controlled by lateral cephalometry and, in addition, computed tomographic (CT) scans were performed pre- and post-operatively. Three-dimensional (3D) CT reconstructions and stereolithographic models served for treatment planning and for deciding on the level of the osteotomy. In the edentulous patients the traction wires were fixed with micro-titanium mesh or to a novel modular retention system; in the other cases a tooth-borne fixed appliance was utilized. Speech assessment was made by a speech therapist and aerophonoscopy.

RESULTS: After a modified Le Fort I/Le Fort II osteotomy without down-fracturing the maxilla, distraction was started. In all subjects distraction was stopped after slight sagittal overcorrection (20–30 mm). After 3–5 weeks of rigid retention the halo was dismantled and night-time retention performed with a face mask. The first two subjects have shown skeletal stability for almost 1 year. CT scanning suggests new bone formation in the pterygoid-maxillary space. The aesthetic improvement was judged by the patients as impressive and no deterioration of velopharyngeal sufficiency was seen.

CONCLUSION: Callus distraction offers new perspectives in the treatment of midfacial atrophy and hypoplasia. The major advantage is the ability to direct and control the movement of the maxilla during distraction. In specific cases callus distractions seems to be an alternative to 'conventional' orthognathic surgery.

35 MASTICATORY MUSCLES IN FACIAL ASYMMETRIES—A COMPUTER TOMOGRAPHIC ANALYSIS

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AIM: Analysis of the volume and density of the masseter and pterygoid muscles in subjects with facial asymmetries.

MATERIAL: Computer tomographic (CT) scans of 17 subjects suffering from different types of asymmetries (lateral mandibular shifts, craniofacial asymmetries, oto-mandibular dysostosis) in comparison with the CT-data of a control group (n = 55).

METHODS: The examinations were performed with the Somatom CT scanner by using the spiral-CT-mode. The evaluation was carried out directly on the monitor within each axial scan by measuring the area and the density of the muscles on the right and left hand sides. By this procedure mean values and standard deviations as well as maximum and minimum values were registered. Based on these data the muscle volumes were calculated comparing the values of the right masseter and pterygoid with those on the left-hand side. The volumes were also analysed in a ratio of both sides.

RESULTS: In the control group and those subjects showing lateral mandibular shifts, the volumes of the masticatory muscles were calculated almost without difference, showing a ratio of nearly 1:1. The density of the muscles ranged between 55 and 61 Hounsfield units. In contrast to these symmetric findings, noticeable asymmetries of the masticatory system were identified in the subjects with craniofacial asymmetries. The calculated muscle volumes differed widely between both sides. The values of the ratios ranged from 0.6–2.4 showing partly striking deviations from symmetric relationships. In subjects with oto-mandibular dysostosis, a reduced volume of the masticatory muscles was registered up to 10 cm³ on the affected side.

CONCLUSIONS: In subjects with craniofacial asymmetries discrepancies of the masticatory muscles are to be found. Attention has to be paid to both the hard and the soft tissue deviations with respect to aspects of craniofacial development and to the prognosis of therapeutic procedures.

36 CORRELATION BETWEEN ELECTROMAGNETIC ARTICULOGRAPHY, PALATOGRAPHY AND LOGOPEDIC DIAGNOSIS

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INTRODUCTION: It is important to examine tongue movements more closely by applying objective methods in order to clarify the aetiological significance of orofacial malfunctions for development and persistence of malocclusions and speech disorders. The aim of this study was to compare electromagnetic articulography measurements with functional and palatographic findings.

SUBJECTS AND METHOD: In a study population of 30 adults tongue movements were measured with the Articulograph AG 100® of the Carstens Medizinelektronik by repeated swallowing and swallowing of water. In addition to common orthodontic diagnostic procedures, a logopedic diagnosis and palatography was applied.

RESULTS: The most apparent functional results were found in the lip position and its appearance, and in the orofacial muscles which displayed hyperactivity during swallowing and during palatographic examination. It was shown that unusual recordings by electromagnetic articulography were related to pathologic findings in other diagnostic procedures. **CONCLUSION:** Electromagnetic articulography is suitable as a diagnostic aid in establishing and recording deviations of the intraoral patterns of the tongue during swallowing and articulation. In contrast to existing procedures, it is possible to register tongue movements more accurately and to evaluate the position of the tongue surface in relation to the palate and the incisors.

37 EXPERIENCES WITH THE USE OF THE STRAUMANN ORTHOSYSTEM FOR ANCHORAGE WITH AN IMPLANT IN THE PALATE

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Twenty-five patients are undergoing treatment whereby an implant in the palate is used as anchorage. The age of the patients varies between 11 and 50 years. During the healing phase, after insertion, two implants became loose and were replaced. The possible reason for these early failures will be discussed and the use of a protecting, flexible splint during the osseointegration phase will be demonstrated.

The technique used for determination of the proper location of the implant (based on the use of a splint) and the method of surgical insertion will also be presented. The technique for determination of the location was developed after an implant caused pain by impinging on the incisive nerve. In adults, the implant is inserted in the midline and in children and adolescents slightly lateral to the midline. This differentiation is made to avoid the midpalatal suture in order to have the implant surrounded by solid bone. Two types of palatal arches connecting the teeth to the implant will be described. The implant is being used as anchorage for distalization of posterior and anterior teeth in the maxilla as well as for intrusion and torque of maxillary incisors.

All implants have been stable when loaded with orthodontic forces, i.e. the treatment can be carried out without loss of anchorage. The technique for and the rapid healing after explantation when the treatment has been completed will also be presented. Histologic examination of explanted implants demonstrates the excellent osseointegration of the orthodontically loaded implant.

38 OUTCOME FOLLOWING MAXILLARY SURGERY IN CLEFT AND NON-CLEFT PATIENTS

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AIM: To compare the hard and soft tissue changes following Le Fort I osteotomy in cleft and non-cleft skeletal Class III patients.

METHOD: Two groups of patients with maxillary hypoplasia who had a Le Fort I surgical advancement correction were studied. Twenty-four consecutively treated cleft patients (treated to a standardized regimen of alveolar bone grafting and pre-surgical orthodontics) were compared with 24 consecutive non-cleft patients. Both received a standardized orthodontic and surgical approach to correction following a previously agreed protocol. The resultant change and stability in hard and soft tissues at 8 weeks (T2) and 1 year (T4) after surgery was determined from standardized cephalometric serial records.

RESULTS: In the cleft group the mean maxillary horizontal movement was 10.1 mm forwards (range 4.6–17.6 mm; the mean relapse at T4 was 0.66 mm (range –3.2–1.45 mm). This constituted a 6.5 per cent relapse. The vertical correction at ANS ranged from 14.3 mm extrusion to 2.4 mm intrusion. Examining deliberate vertical corrections of over 2.5 mm (n = 8), there was a subsequent 16 per cent relapse at 1 year. In the non-cleft group the mean horizontal correction was 8.0 mm (range 2.6–14.6 mm) and the mean relapse 1.1 mm. This constituted a 13.5 per cent relapse. The vertical correction at ANS ranged from 4.0 mm extrusion to 4.7 mm intrusion. There was a 33 per cent relapse at 1 year post-surgery for previous movements of over 2.5 mm (n = 8). Soft tissue response to bone movements was more predictable in non-cleft than cleft patients particularly with regard to horizontal movements. Changes at 1 year post-surgery were negligible.

CONCLUSIONS: In this group of cleft patients, following a particular protocol of treatment, the Le Fort I osteotomy results 1 year post-operatively were as stable as those for non-cleft patients.

39 EARLY INTERCEPTIVE TREATMENT IN GERMANY

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AIM: Evaluation of early interceptive treatment in Germany based on a questionnaire.

MATERIALS AND METHOD: A questionnaire was developed comprising the following topics of early interceptive treatment: frequency, indication, diagnostic records, duration, and an overall assessment of the benefits and effectiveness based on the everyday experience of the orthodontists. Every orthodontic office listed in the German Yellow Pages (n = 2001) was enrolled in a postal survey, 712 offices responded by mailing back the questionnaire.

RESULTS: Early interceptive treatment was utilized in 99 per cent of the offices. Usually patients receiving early treatment comprised 10 per cent of the total load of the practice. Over 90 per cent of the orthodontists judged a Class III malocclusion as an indication for early interceptive treatment. The majority did not consider Class II malocclusions,

deep bites, increased overjet, diastema, impacted incisors or crowding as an indication. Correction of the following discrepancies provoked controversy: open bite, transverse problems, asymmetries and habits. Typical orthodontic records for early interceptive treatment included dental casts and a panoramic radiograph. Approximately 60 per cent of the offices also took a lateral cephalometric radiograph and/or photographs as diagnostic records. Nearly 3 per cent of the orthodontists routinely took a hand-wrist radiograph at the beginning of early treatment. The duration of early interceptive treatment was less than 18 months in most offices. In 40 per cent of the practices early treatment was considered to decrease the effective total treatment time. Ten per cent of the offices stated that early treatment sometimes makes later comprehensive treatment unnecessary. Other benefits mentioned were the improved quality of the final result or a simplified total treatment (approximately 25 per cent of the answers).

CONCLUSIONS: Early treatment is accepted as a measure to improve the developing dentition within a short time period. The need for hand-wrist and cephalometric radiographs should be evaluated carefully on an individual basis. A consensus concerning the classic indications for early treatment such as asymmetries, transverse problems and habits should be found.

40 THE INFLUENCE OF STEROID TREATMENT ON ORTHODONTICALLY INDUCED TISSUE REACTION

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AIM: To evaluate tissue reaction to orthodontic treatment with long- and short-term steroid treatment.

MATERIALS: Sixty-four six-month-old Wistar rats divided into a normal, an acute and a chronic group.

METHOD: The interaction between acute and chronic response to steroid treatment and the tissue reaction to orthodontic tooth movement was analysed following three weeks of mesial movement of the first maxillary molar. Reaction to steroids was generated by daily injection of 8 mg/kg/day of methylprednisolone (Solu-medrol, Upjohn Pharmaceutical). Intravital staining was performed 7 and 2 days before sacrifice. Tooth displacement was estimated by comparing the treated and the untreated sides of the excised maxilla. On thin horizontal sections the area of the alveolar socket, the periodontal ligament (PDL) and the relative extension of resorption and apposition were measured coronally and apically at four sites, mesially, distally, buccally and lingually. Comparisons were made by Wilcoxon and Mann-Whitney tests.

RESULTS: A significant increase in the rate of tooth movement was observed in the chronic drug group. The area of the alveolar bone socket was increased by orthodontic treatment. This effect, which was influenced by the level and the site, was reduced by the addition of corticosteroids. The area of the PDL was significantly reduced in the corticosteroid

drug groups, but the effect was influenced by site. All sites except at the lingual aspect at the coronal level exhibited a reduced PDL width. Corticosteroid had a significant influence on the extension of resorption on both sides at both levels. On the non-treated side the cortisone treated rats exhibited less resorption than the controls. In the case of the orthodontically treated, the resorption was, on the contrary, about twice as high on the mesial site of the chronic treated group, than of the acute and control groups. On the distal surface resorption was decreased in both the drug treated groups, although mostly in the acute. The relative extension of formation was considerably less influenced by the use of the drug. **CONCLUSION:** Normally applied pharmacological glucocorticoid drug therapy changes the bone turnover rate, but the reaction is time-dependent. Following short-term duration of drug therapy, the tissue reaction to orthodontic forces slows down, whereas chronic use seems to lead to a secondary hyperparathyroidism and consequently more rapid tooth movement and need for more frequent control.

41 POST-RETENTION ASSESSMENT OF OVERBITE STABILITY IN SUBJECTS WITH CLASS II DIVISION 2 MALOCCLUSIONS

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AIMS: To evaluate the long-term stability of deep overbite correction in subjects with Angle Class II division 2 malocclusions and to search for predictors for post-retention overbite.

MATERIAL: Study models and cephalograms of 62 (31 males, 31 females) Class II division 2 subjects with initial deep overbite and successful orthodontic treatment as judged clinically at the end of treatment. The material was selected from the long-term sample collected at the Department of Orthodontics, University of Washington.

METHODS: Thirty-seven cephalometric measurements and 12 model measurements were evaluated before treatment (T1), after treatment (T2), and post-retention (T3, minimum of 8.6 years). Independent *t*-tests for 37 cephalometric measurements and 12 model measurements were performed in order to compare the stable group and the relapse group at each of three time periods (T1, T2, T3). Multiple stepwise regression analysis was used in an attempt to identify any clinically useful predictors of the post-retention overbite by using T1 variables.

RESULTS AND CONCLUSIONS: Subjects with very retroclined pre-treatment maxillary and mandibular incisors tended to have a deeper initial overbite and a tendency to return to their original relationship by the post-retention stage. Post-treatment vertical growth contributed to maintenance of stable overbite correction. By stepwise multiple regression analysis, initial overbite was selected as the most important predictor of post-retention overbite. Initial overbite was positively related with post-retention overbite.

42 RANDOMIZED PROSPECTIVE CLINICAL TRIAL EVALUATING EARLY TREATMENT OF CLASS II MALOCCLUSIONS

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KEYNOTE ADDRESS

AIMS: To compare early treatment for Class II malocclusions using a headgear/biteplane combination or a bionator with no early treatment. The aims were to examine the efficacy of these approaches, including short-term stability, and the associated risks and benefits.

SUBJECTS: Three hundred and twenty patients who were nine years of age and had Class II molar relationships.

METHODS: The subjects were randomly assigned to one of three groups: observation, headgear with biteplane or bionator. All were followed for 24 months or until a Class I molar relationship was obtained. Following this treatment phase, the appliances were removed and the patients were observed for an additional 12 months. The experimental design then called for a phase 2 treatment when it was indicated and accepted. Standard orthodontic records were taken at the start and completion of early treatment, 6 months and 1 year after early treatment and yearly thereafter. In addition, behaviour, growth and functional assessments were made at these times.

RESULTS: Both early treatment approaches were effective in reducing Class II molar relationships and overjet and permanently improved the apical base relationship, but there were no jaw-specific differences among the two treatment approaches. Both appliances resulted in significant unstable dentoalveolar effects with the headgear/biteplane protocol distalizing the maxillary molars and incisors while the bionator primarily advanced the lower incisors. Early treatment also improved the malocclusion as measured on study models and as assessed by orthodontists. Early treatment did not relate to measures of physical or dental maturation and did not improve self-esteem. However, it did reduce the risk of incisor injury and was neutral with regard to temporomandibular dysfunction symptoms.

CONCLUSION: This investigation is still in progress and phase 2 results will be assessed at the completion of that part of the study.

43 ARRESTED TOOTH ERUPTION—A DISTURBANCE IN THE PERIODONTAL INNERVATION?

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BACKGROUND: Arrested tooth eruption is a developmental variant whose aetiology is unknown, although certain general factors, e.g. endocrinological, regulating the process are known.

AIMS: To evaluate the eruption pattern in a group of patients with unilateral arrested tooth eruption and compare it with the recently published innervation pattern of the jaws.

MATERIAL: The material comprised radiographs from 27 patients referred for counselling during 1993–1998 to the Department of Orthodontics, Copenhagen School of Dentistry, from municipal child dental care clinics in Denmark.

METHODS: On each radiograph the location of unilateral eruption arrest, root morphology, the contours of the periodontal membrane, pericoronal space, and pulp cavity radiolucency were analysed. Sixteen patients were questioned about their sight, hearing and possible earlier infections in the oral cavity, as well as about complications related to childhood illnesses.

RESULTS: Arrested eruption occurred within jaw regions (fields) with a common innervation. Altered tooth morphology was observed when more than one tooth was affected by arrested eruption. These circumstances, and also the fact that in 10 subjects the condition was associated with temporary hearing loss in infancy in the affected side, make it likely that unilateral arrested eruption is due to a temporary or permanent disruption of the periodontal nerve supply to the region involved.

CONCLUSION: In elucidating the aetiology behind arrested tooth eruption it is important to distinguish between unilateral and bilateral manifestations. In unilateral arrest there appears to be a connection between the teeth involved and their innervation.

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44 THREE-DIMENSIONAL ANALYSIS OF CRANIOFACIAL GROWTH IN A PATIENT WITH APERT'S SYNDROME

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AIM: To analyse craniofacial growth and tooth eruption in three-dimensions in a subject with Apert syndrome.

MATERIAL: Computed tomographic (CT) data were available for a patient with Apert syndrome. The scans were performed at the ages: 9 and 21 months, and 7 and 10 years of age, respectively. All scans were carried out for diagnostic, treatment planning, and follow-up purposes. The patient had a surgical frontal bone advancement at the age of 22 months. No other craniofacial surgical procedures were undertaken in the observation period.

METHODS: All scans were performed with a Siemens CT-scanner using the same protocol. A slice thickness of 2 mm was employed. Three-dimensional (3D) reconstruction of the craniofacial region and segmentation of the teeth were carried out for all four datasets using the software package Mvox (Bro-Nielsen, 1996). Superimpositions of the models

were made on the anterior cranial base and on internal stable anatomical structures in the maxilla and the mandible, extending the methods of Björk and Skieller (1976, 1983) from two- to three-dimensions. Furthermore, a dynamic growth simulation of the mandible was generated.

RESULTS: A qualitative assessment of the craniofacial growth revealed a lack of forward growth of the frontal bone. The calvaria showed marked growth in both height and width. The maxilla revealed diminished sutural growth in all three planes of space, leading to severe crowding of the teeth, disturbances of tooth eruption, and malocclusion. The mandible showed normal growth, remodelling, and tooth eruption in all three planes of space.

CONCLUSION: The present report presents a qualitative 3D analysis of craniofacial growth and tooth eruption in a case of Apert syndrome followed longitudinally from 9 months to 10 years of age. Previous studies of normal and abnormal craniofacial growth have mostly been limited to two-dimensions. Because of the nature of Apert syndrome, the present study reveals new information both about abnormal (calvaria, cranial base, and maxilla) and normal (mandible) craniofacial skeletal growth and tooth eruption.

This study was supported by Dannin's Fund, the John and Birthe Meyer Foundation, and the Danish Dental Association.

45 A BIOMETRIC COMPARISON OF ORTHODONTIC IMAGING TECHNIQUES

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AIM: Comparison of different diagnostic techniques often causes difficulties in appropriate assessment of method reliability and validity. This presentation aims to illustrate the information necessary for evaluation of results from a biometric point of view.

MATERIAL: The data were obtained from 50 orthodontically treated patients, on whom video imaging-based sound cephalometry as well as conventional radiographic cephalometry had been performed.

METHOD: Based on this data-set a catalogue of essential biometric information for adequate presentation of intra-individual differences in accuracy and precision as well as for the assessment of method congruence was developed.

RESULTS: The numerical information on validity was obtained by paired *t*-tests for differences in accuracy. The Maloney-Rastogi-test, for comparative evaluation of measurement precision, was used to illustrate the essential need for intra-individual data comparison. Ignorance of the latter may yield erroneous conclusions on both precision and reliability of orthodontic imaging methods. Graphical presentation could be based on the well-known scattergrams. However, with Bland/Altman-plots more biometric information could be provided under optical aspects.

CONCLUSION: A combination of testing for accuracy and validity is necessary to obtain sufficient information to compare orthodontic imaging techniques. The presented tests are available in the SPSS and Excel programs, although they might not always be part of the standard statistical procedure.

46 THREE-DIMENSIONAL COMPUTER TOMOGRAPHY

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KEYNOTE ADDRESS

The interaction and manipulation of three-dimensional images (3D) were limited by their availability as static hard-copy on transparent film. While 3D workstations became available synchronously with the development of surface imaging technology, the cost of such workstations was initially prohibitive for most potential users. The development of commercially available medical 3D imaging software has made 3D workstations affordable. Interrogation of the 3D imaging data base using such workstations allows registration of serial images, superimposition of selected hard and soft tissues, interactive surgical simulation and evaluation of change over time, due to growth, ageing or intervention.

The fabrication of space-filling fully 3D anatomic replicas has become an important alternative presentation of 3D data acquired by computer tomography or magnetic resonance scanning. Also the production of such 3D individual models requires sophisticated computer technology. The replicas can be examined manually, cut with surgical tools to practice known operations or to simulate novel ones, and used to fabricate custom implant or pre-bent internal fixation devices. While facsimiles so produced provide an excellent single surface with an exocranial or endocranial replication, the ability to produce the skull facsimile with anatomic fidelity of both internal as well as external surfaces is limited with milling machines. Stereolithography, a technology introduced in the early 1990's, has excellent capability to produce very complex objects.

This lecture will focus on the development of 3D modelling technology in oral and maxillofacial surgery, the basic knowledge of how facsimiles are produced and presentation of cases with special focus on the fields of orthodontics and orthognathic surgery, respectively.

Lambrecht J Th 1995 3-D modelling technology in oral and maxillofacial surgery. Quintessence, Chicago

47 ELASTIC TONGUE ELEVATOR: TREATMENT RESULTS IN SUBJECTS WITH CLASS III HYPERDIVERGENT MALOCCLUSIONS

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AIM: To study the vertical changes in the posterior facial height with the use of a removable mandibular functional appliance, the elastic tongue elevator (ETE) in the treatment of Class III hyperdivergent malocclusions.

MATERIAL: Cephalometric data of 24 Class III hyperdivergent patients (11 males and 13 females) aged 6–13 years (mean 9.4, SD \pm 3) treated for 2 years with an ETE.

METHODS: The patients wore the ETE 20 hours a day for 2 years (SD \pm 2) and carried out 12 clenching exercises with the appliance in the mouth three times a day for a period of 3 months. Orthopaedic traction, rapid maxillary expander, Quad-Helix were alternately applied to the maxilla. The ETE is a mandibular plate with elastic biting planes between the dental arches. The purposes of the ETE include: modification of lingual posture and increase in muscular activity to train orofacial muscles in the early therapy of skeletal open bite. Control group: from a longitudinal study at King's College School of Medicine and Dentistry, London. The two groups were matched according to sex and age. (Statistical significance: independent sample *t*-test.)

RESULTS: After 2 years of treatment, the ramus length increased from 40.7–44.9 mm ($P < 0.001$), the posterior facial height from 66.8–71.8 mm ($P < 0.05$) and the face height ratio from 58.1–60.1 per cent ($P < 0.05$). The angles between the basicranial and mandibular line decreased by 1 degree (NS) and between the maxillary and mandibular line by 1 degree (NS).

CONCLUSIONS: The ETE is effective in opposing the vertical growth tendency of Class III hyperdivergent patients. A statistically significant increase in some values related to the vertical posterior dimension was obtained with a subsequent morphologic improvement of the vertical dysplasia.

48 COMPARISON OF SKELETAL EFFECTS IN CERVICAL HEADGEAR AND FR-II TREATMENT

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AIM: To determine the dentoalveolar and skeletal effects of cervical headgear (HG) and functional regulator type II (FR-II) short-term treatment in subjects with an Angle Class II division 1 malocclusion.

MATERIAL: Dental casts and lateral cephalograms pre- and post-treatment from 20 patients treated with cervical HG and 20 patients treated with the FR-II appliance.

METHODS: Patients showing an increased overbite (≥ 5 mm) and a skeletal Class II relationship (ANB > 5 degrees) were examined prior to and after a treatment period of approximately 1 year. Only cervical HG with short outer bows and FR-II were used. Occlusal and cephalometric findings were evaluated and compared. Paired *t*-tests were performed.

RESULTS: Treatment duration was 13 months for the HG group and 12 months for the FR-II group. Both appliances significantly ($P < 0.001$) improved distal movement towards

a neutral occlusion in the anterior and posterior arches. The HG group showed highly significant ($P < 0.001$) reductions of SNA and ANB angles towards a skeletal Class I. Significant ($P < 0.01$) changes occurred in the maxillary plane angle and inclination of the lower incisors. In the FR group, no significant alterations of sagittal relationship towards a skeletal Class I were found. Significant ($P < 0.05$) alterations occurred in the mandibular plane angle and incisor inclination. In both groups, the Wits' index was significantly ($P < 0.01$) reduced.

CONCLUSION: The cervical HG appears to be more effective in achieving sagittal improvements in patients with a skeletal Class II anomaly than the FR-II in short-term treatment.

49 THREE-DIMENSIONAL CEPHALOMETRY FROM COMPUTER TOMOGRAPHIC SCANS TO ASSESS CRANIOFACIAL GROWTH

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AIM: Treil *et al.* (1997) proposed a cephalometric analysis from axial computer tomographic (CT) scans using the C2000[®] software to calculate the parameters of three-dimensional (3D) reconstructions. The aim of this study was to assess the reliability of this new method within a group of orthomorphic subjects.

SUBJECTS: Twenty-nine subjects, 13 females (45 per cent) and 16 males (55 per cent); mean age 30.3 ± 13.8 years; mean height 1.69 ± 0.08 m; mean weight 65 ± 13 kg comprised the sample. The absolute exclusion criteria were the presence of a potential past or evolutive maxillofacial pathology. Treil's cephalometric analysis was performed using the C2000[®] software (CIRAD) collecting 168 angular values and 69 areas. Each subject had a CT scan and a 3D reconstruction of the whole maxillofacial region. The data of each patient were analysed twice using the software Ceph3D[®] (CIRAD). A conventional cephalometric analysis including the values of SNA, SNB, ANB, Occlusal/SN Go-Gn/SN and FMA was performed and a 3D cephalometric analysis was carried out by calculating the following angles: cranial-facial, cranial-mandibular, infraorbitomallear-facial, infraorbitomallear-lower facial, infraorbitomallear-mandibular, infraorbitomallear-cranial, interarch-upper arch, interarch-lower arch, infraorbitomallear-interarch, infraorbitomallear-upper arch, infraorbitomallear/lower arch. The statistical analysis was performed with S Plus[®] software. Conventional cephalometric analysis showed that even if the sampling was not strictly orthomorphic the chosen parameters were not statistically different from commonly accepted values among the Caucasian population.

RESULTS: The 3D cephalometry demonstrated that the infraorbitomallear plane and the facial plane were strictly orthogonal in the studied sample (mean value of infraorbitomallear-facial angle: 89.37 ± 4.51 degrees). It also confirmed that the upper and lower arch planes were parallel

to each other (mean angle = 0.75 ± 1.013 degrees) and were both parallel to the infraorbitomalleolar plane chosen as the horizontal standard (mean 3D angle between upper arch plane and infraorbitomalleolar plane = 1.875 ± 1.5 degrees; mean 3D angle between lower arch plane and infraorbitomalleolar plane = 1.625 ± 1.64).

CONCLUSION: Treil's cephalometry is a reliable method of 3D assessment of maxillofacial dysmorphosis. Its first application could be orthognathic surgery.

50 TISSUE REACTION TO ORTHODONTIC TOOTH MOVEMENT. A NEW PARADIGM

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SHELDON FRIEL MEMORIAL LECTURE

Direct or indirect resorption can both be perceived as a reaction to an applied force. This is in contrast to the orthopaedic surgeons who describe apposition as the reaction to loading of bone.

A histomorphometric study of the circum alveolar bone reaction to a force system generating translation of premolars and molars of five *Macaca fascicularis* monkeys will be described. Three force levels, 100, 200 and 300 cN were applied for a period of 11 weeks. Undecalcified serial sections were cut parallel to the occlusal plane, and a grid consisting of three concentric outlines of the root intersected by six radii was placed on each section. Thereby areas anticipated to be submitted to different stress/strain distributions were isolated. *A posteriori* tests were utilized in order to separate areas that differed with regard to parameters reflecting bone turnover. Based on these results a new hypothesis regarding tissue reaction to orthodontic force was suggested.

The direct resorption could be perceived as a result of the lowering of the normal strain from the functioning periodontal ligament and as such as a start of bone remodelling, in the bone biological sense of the word. The indirect remodelling could be perceived as a sterile inflammation attempting to remove ischemic bone under the hyalinized tissue. At a distance from the alveolus dense woven bone was observed as a sign of RAP (Regional Acceleratory Phenomena). The apposition could, according to the new hypothesis, be perceived as a result of bending of the alveolar wall produced by the pull from the Sharpey fibres. The above suggested interpretation of tissue reaction would be shared with the bone biologists.

51 OCCLUSION—WHY CARE?

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AIM: To evaluate the impact of malocclusion symptoms on temporomandibular joint (TMJ) function.

SUBJECTS: One hundred children at the typical age for orthodontic treatment (8–11 years).

METHODS: Malocclusion symptoms considered to influence TMJ function were rated on study casts according to their severity resulting in an AFIV (Assumed Function Impeding Value). All individuals were clinically examined according to Helkimo's clinical dysfunction index (D_i) and answered a questionnaire to define the Helkimo anamnestic index (A_i). The results were tested using the Kruskal-Wallis and the Mann-Whitney *U*-test.

RESULTS: The mean AFIV was 53.8 ± 23.4 . Eighteen per cent of the children demonstrated a D_i of 0, 34 per cent an index of I, 38 per cent of II, and 10 per cent of III. For the different scores of the D_i for TMJ pain, range of motion, pain on movement, and muscle pain significantly different AFIVs were found. There were also significant differences between the two genders. No differences, however, could be observed between different A_i scores and different AFIVs. The AFIV increased with the severity of the D_i and its different items. Most of the differences between the scores were statistically significant. The correlation coefficient between the D_i and AFIV was 0.55, indicating that roughly 30 per cent of the observed TMJ functional disturbances were influenced by malocclusion symptoms.

CONCLUSION: The results of this study indicate a correlation between occlusal characteristics and mandibular function. Because of this correlation all efforts are required to establish an optimal occlusion during orthodontic treatment.

52 IMPAIRED BREATHING IN INTERCEPTIVE ORTHODONTICS

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AIM: To evaluate the possible relationship between airway obstruction and malocclusion, thus assessing the need for co-operating with ENT surgeons and paediatricians in evaluating the mode of breathing in young children during orthodontic assessment.

SUBJECTS AND METHOD: Thirty-five patients (mean age 9.8 years) presenting impaired breathing were referred for evaluation to the Orthodontic Department by the ENT Section of the Department of Paediatrics. From the files of the Orthodontic Department a control group of 35 subjects of matching age and sex was selected. Criteria for selection excluded signs of impaired breathing and skeletal malocclusions (related to all planes of reference), and only minor dental problems were accepted. Medical history was obtained through a questionnaire, functional tests were performed and full records obtained.

RESULTS: In the cephalometric analysis, highly statistically significant differences were observed in all the parameters relating to the soft tissue in the nasopharyngeal area ($P < 0.002$), confirming the airway obstruction. Small differences were, however, observed in the parameters regarding the skeletal pattern, and only some values related to the vertical dimension were statistically different (Y angle, Sn-Md, Mx-Md), showing an increased vertical dimension in the

experimental group. The inclination of the upper incisors to their dental base was reduced in the mouth-breathers (I/Mx, $P < 0.05$). Females seemed to present a more marked vertical development than males. No statistically significant correlation was observed between the degree of airway obstruction and the severity of the malocclusion.

CONCLUSIONS: The results would appear to show that individual factors may play a major role in the development of malocclusions related to airway obstruction, and that impaired breathing can represent a co-factor in the individual response. It would therefore appear mandatory to carefully assess the mode of breathing in young children to avoid the risk of possibly negative environmental effects of airway obstruction on craniofacial morphology.

53 CEPHALOMETRICS—A LOOK BACK AND A LOOK FORWARDS

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KEYNOTE ADDRESS

The Angle classification and standardized radiographic imaging of the head stand as two major event since the 19th century for diagnosis, differential diagnosis, as well as analysis of facial growth and treatment results. Currently, cephalometrics has focused mainly on the sagittal projection of the face, underpinning the Angle classification without realization that the frontal projection reveals facial breadth relationships and facial asymmetry. Moreover, a vertex image can be obtained with standard equipment for three-dimensional (3D) analysis of the face. Proportional analyses of man's face have been made historically in both norma frontalis and norma lateralis. That approach was modified by de Coster by distortion of a co-ordinate system to illustrate the characteristic facial configuration of an individual. It also enhances recognition of the patient's individual norm that determines the ultimate treatment objective. The 'mesh diagram' has also been used for analysis of the frontal projection and for longitudinal studies of facial growth. When applied to the conventional lateral and frontal projections as well as to the vertex projection, the foundation for 3D analysis of the head is laid. Digital photographic and roentgenographic images already enable computer storage and instant retrieval for analysis with appropriate illustration. Nonetheless, current products are still focused on the lateral image and they still deliver conventional analyses. The 3D 'mesh diagram' analysis can be developed for inventive and rational orthodontic treatment.

54 THE USE OF THREE-DIMENSIONAL OPTICAL SCANNING TECHNIQUES

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KEYNOTE ADDRESS

The interaction between individuals and our first impressions of people are governed by the way faces are perceived.

Measurements of the face are of vital importance in the assessment of facial reconstructive surgery and also in forensic science (Cutting *et al.*, 1986; Moss and Linney, 1990; Vanezis *et al.*, 1989). Unacceptable facial appearance has to be related to the norm for that age and the areas of unacceptable growth identified by comparison with the average normal face. The aim of this investigation was to address the questions: 'What is normal?' and 'Is normal beautiful?'

Two groups of individuals were scanned using a three-dimensional (3D) optical surface scanner. The first was a group of 40 males and females with a Class I occlusion who had had no orthodontic treatment and the other was a group of 30 male and female models. Each of the people were scanned using an optical surface scanner, each group was averaged and then the differences between the groups were displayed using a registration programme. Average is a concept that arises from being able to register 3D data sets to create average faces for select groups of the population. This provides a better understanding of facial morphology and will be illustrated by both orthodontic and surgical cases.

This presentation will also describe the use of a new portable scanner and the use of 3D data from the optic surface scanner in forensic science. If an individual is suspected of committing a crime that has been recorded by a security video or photographic system, one means of establishing innocence is to compare the shape and proportions of the face of the accused with that of the subject in the security images. Similarly if a skull is found in suspicious circumstances and cannot be identified from dental records there is a requirement to identify the individual to whom the skull belongs, data from the optical scanner has been used for this purpose (Vanezis *et al.*, 1989).

It is recognized that certain facial characteristics are familial in origin but can they be defined and differentiated. What features of our faces are like those of our parents? In order to analyse these features members of family groups were scanned and the scans analysed to see whether it was possible using new methods of shape analysis to detect inherited facial features (Henessey *et al.*, 1989). The analysis of facial shape has indicated that certain features of the chin, nose and eyes are similar in grandparents, parents and children. These methods of shape analysis are also useful in demonstrating the differences between the shape of the face in cleft and non-cleft subjects.

55 BONE CONDENSING AND ITS SIGNIFICANCE IN ENDOSTEAL PALATAL IMPLANTS

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AIM: To show a surgical procedure (bone-condensing, osteom-technique) for preparation of the implant bed, which offers more security with regard to primary stability of palatal endosteal implants in soft maxillary bone.

SUBJECTS AND METHODS: From an ongoing study, 15 patients were treated with palatal implants and the surgical method of bone condensing. Appropriate to the anatomical requirements of a deep and/or steep palatal roof as well as for the possibility of an axial implant loading with the appropriate inclination, a corresponding condensation instrument will be presented. The planning of the implant position including the step-by-step treatment and the following radiographic controls will be described.

RESULTS: In further pilot-studies, palatal implants were lost at a rate of approximately 15 per cent without any orthodontic load. In this study it was determined that the bone condensing procedure in the palatal maxilla is an interesting, non-ablative, surgical technique to prepare the implant bed in soft maxillary bone structures without danger of thermal damage by rotating instruments. Appropriate to the biomechanical planning of endosteal palatal implants it is possible now to increase the primary stability, with a reduction of implant loss before orthodontic loading, and to further increase the surrounding bone density.

CONCLUSION: With bone condensing it is possible to enlarge the implant indications and increase the security in treatment especially in tender bone qualities.

56 DISC POSITION CHANGES DURING HERBST TREATMENT. A PROSPECTIVE MAGNETIC RESONANCE IMAGING STUDY

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AIM: To assess any possible changes in the position of the articular disc relative to condyle and fossa during different phases of Herbst therapy using the method of magnetic resonance imaging (MRI).

SUBJECTS: Fifteen consecutive subjects with Class II malocclusions treated with the Herbst appliance for 7 months.

METHOD: With the aid of a disc position index, static and dynamic (video) parasagittal MRIs of both joints were analysed four times during the course of Herbst treatment: (1) pre-treatment, (2) start of treatment, when the appliance was placed, (3) after 6–12 weeks of treatment and (4) post-treatment, when the appliance was removed. The static MRIs were obtained with the mouth closed and wide open. The dynamic MRIs were taken during the mouth open-close motion cycle.

RESULTS: (1) Pre-treatment, the disc was in an almost centred position when the mouth was closed and in a retrusive position when the mouth was open. (2) At the start of treatment when the mandible was displaced forwards and the condyles positioned on the top of the articular eminence, the disc attained a more pronounced retrusive position. (3) After 6–12 weeks of treatment as well as (4) post-treatment a retrusive position of the disc prevailed while the original condyle-fossa relationship was restored. The interplay between condyle and disc movements during the different phases of Herbst treatment will be demonstrated in two patients by means of MRI-video recordings.

CONCLUSION: Herbst appliance treatment tended to result in a retrusive disc position. This could imply that the appliance could be useful in the treatment of patients with anterior disc displacement.

57 MANIPULATION OF CRANIOFACIAL BONE GROWTH IN HUMANS AT ADULthood EXECUTED WITH THE HERBST APPLIANCE

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INTRODUCTION: Temporomandibular joint condyles possess the capability to change morphology during biomechanically loading by modelling. This effect has been detected during Herbst treatment using computer tomographic scanning and radiographs of condyles (Paulsen *et al.*, 1995; Paulsen, 1997).

AIM: To identify differential changes in growth direction of condyles with changes in mandibular rotations of patients treated with the Herbst appliance.

SUBJECTS AND METHODS: One hundred consecutive Herbst patients treated in the period of puberty to adulthood, described from lateral cephalograms taken in occlusion and during maximal opening using Björk's method. Skeletal ages were calculated using the Tanner-Whitehouse-2-method, modified for the Danish population. Radiographs were taken pre- and post-treatment and yearly thereafter until cessation of growth. Lateral cephalograms and images of dental arches were digitized and assessed using a special computer program (TIOPS™).

RESULTS: The treatment analysis of the mean patient revealed a significant increase in the length of the mandible (pgn-cd) and in height of the ramus (tgo-cd). The gonion angle (ML/RL,cd) opened. The mandibular alveolar process with incisors tilted forward. The mandible showed total forward rotation. Treatment elicited impeded matrix rotation of the mandible, confirming previously found changes at the condyles (Paulsen, 1997; Paulsen *et al.*, 1995). However condyles changed growth direction during treatment in different directions: in a large percentage of patients to a sagittal direction causing a predominant impeded matrix rotation with modelling and nearly unchanged inclination of the mandibular incisors, and in eight patients to a vertical direction resulting in a predominant forward matrix rotation with vertical modelling and proclined mandibular incisors. It was thus possible to change the two extreme types of growth rotation of the mandible in the direction of 'normal' during treatment. After treatment matrix rotations normalized to original directions, if growth was still active.

CONCLUSIONS: The mandibles show total forward rotation. 'Low angle' subjects show impeded matrix rotation of the mandible, rotating backward, and 'high angle' patients anterior rotation of the mandible, forward. Changes in rotations of the mandible can be planned and predicted.

Paulsen H U 1997 Morphological changes on TMJ condyles of 100 patients treated with the Herbst appliance in the

period of puberty to adulthood. A radiographic study. *European Journal of Orthodontics* 19: 657–668

Paulsen H U, Karle A, Bakke M, Herskind A 1995 CT-scanning and radiographic analysis of temporomandibular joints and cephalometric analysis in a case of Herbst treatment in late puberty. *European Journal of Orthodontics* 17: 165–175

58 STRENGTH AND SIZE OF JAW MUSCLES COMPARED WITH LIMB MUSCLES

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AIM: To distinguish between general and craniofacial influences on jaw muscle size and strength.

SUBJECTS: One hundred and twenty-one healthy adult individuals (mean age 23 years) without severe malocclusions or musculoskeletal restrictions.

METHODS: Moments of maximal voluntary bite force, arm flexion force and leg extension force were determined and statistically analysed by a principal component analysis. The ultrasound thicknesses of the masseter, temporal, arm flexor and leg extensor muscles were also measured and subjected to a principal component analysis.

RESULTS: In females, one component was found explaining 59.6 per cent of the original variation. Moments of arm and leg force loaded comparatively (0.887 and 0.834), whereas the moment of bite force loaded low (<0.4). In males, two components were found totally explaining 69.3 per cent of the original variation. The first loaded for arm and leg force moments (0.834 and 0.666), and the second for bite force moment (0.943). For muscle thicknesses, in both females and males, one component was found explaining 54.7 and 49.5 per cent of the original variation in muscle thickness, respectively. Thicknesses of the jaw muscles, arm flexors and leg extensors loaded comparatively (females, 0.612, 0.716, 0.757; males, 0.591, 0.651, 0.620).

CONCLUSION: The size of the muscles of mastication was significantly related to the size of the limb muscles, suggesting that they are both subject to the same metabolic and hormonal influences. However, moments of maximal voluntary bite force were not significantly related to arm flexion and leg extension force moments, indicating that besides the generally influenced muscle size, factors on the craniofacial level, such as craniofacial morphology, contributed to the magnitude of the bite force moments.

59 SKELETAL DISTRACTION FOR MANDIBULAR LENGTHENING WITH AN INTRAORAL TOOTH-BORNE OR HYBRID DISTRACTOR

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AIM: To develop a predictable and cost-effective method of mandibular skeletal deficiency correction for adult or adolescent Class II patients which is easier than the sagittal split osteotomy. The non-extraction hypothesis to correct skeletal mandibular deficiencies with lower incisor crowding or compensations was tested. A question was raised, is it possible to distract between the teeth (intra-arch) first and then to upright or to decrowd the incisors into the regenerated bone?

SUBJECTS AND METHODS: Three phases for distraction osteogenesis were employed: 1) performance of a corticotomy, 2) period of distraction, 3) stabilization. Twenty-one orthodontic patients underwent intraoral corticotomies and application of (ROD™) tooth-borne distraction devices. The patients had gradual bony and soft tissue distraction at a rate and rhythm of 1 mm per day in three divided treatments. A period of stabilization of 6–7 weeks after the last turn was utilized.

RESULTS: Cephalometric analysis showed a significant decrease in denture discrepancy (ANB angle) ($P < 0.005$), increase in mandibular corpus length ($P < 0.05$), increase in mandibular plane inclination to Frankfort plane ($P < 0.05$) and increase in mandibular bend angle ($P < 0.05$). An increase in mandibular bend angle was seen when osteotomies were not completed after circumferential corticotomies. Tooth movement and open bite tendency was minimized when distraction was performed prior to orthodontics or when surgical bone plates were used to augment anchorage.

CONCLUSION: All the patients exhibited marked improvement in their post-operative occlusal status in addition to a dramatic aesthetic improvement. Corticotomies were performed in a surgical office setting, significantly reducing the patient's expenses from the conventional sagittal split osteotomy costs when undertaken in a hospital. Patients underwent advancements of 10–14 mm and were able to return to work (school) only 3 days after the procedure. Full recovery of neuro-sensory mechanisms was also observed 3–7 days post-osteotomy. Intraoral corticotomies performed in conjunction with skeletal distraction appear to offer significant advantages over classic treatment of micrognathia in Class II mandibular deficiency patients. Soft tissues as well as bone are expanded to a normal configuration. Bone of a type native to the region is created and the surgical procedure itself is markedly less traumatic for the patient. There is no donor site morbidity. Teeth are moved through the distraction site with ease.

60 STABILITY FOLLOWING SERIAL EXTRACTION WITHOUT SUBSEQUENT ORTHODONTIC MECHANOTHERAPY

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AIM: To evaluate whether serial extraction treatment protects the dentition from late developmental crowding.

MATERIAL: Long-term dental cast records of 36 subjects from the Burlington Growth Centre; serial extraction treated subjects ($n = 18$) matched with a normal occlusion control group ($n = 18$).

METHODS: A comparison was made between subjects treated with serial premolar extractions, followed by a period of physiological drift without subsequent orthodontic therapy, and an untreated, normal occlusion, control group who received no such supervision. The experimental and control groups were matched in order to allow conclusions to be made with respect to late developmental crowding change when starting from the same baseline values. These measurements were also compared with similar treated group values found in the literature (Little *et al.*, 1990; McReynolds and Little, 1991). The variables measured at post-treatment (T_2) and post-retention (T_3) (minimum post-retention period, 5 years) were irregularity index (Little, 1975), mandibular incisor crowding, mandibular intercanine width, mandibular intermolar width, mandibular arch length, overbite and overjet. Statistical analyses included repeated measurements of variance to determine the effects of treatment, time, gender, and their combinations (time-treatment, and treatment-gender). Pearson correlation coefficients were used to determine if there were simple pairwise correlations between post-retention measurements of mandibular incisor stability, and other post-treatment and post-retention measurements. **RESULTS:** Mandibular incisor irregularity and crowding increased significantly with time in both the serial extraction experimental and untreated control groups ($P < 0.001$). No clinically significant differences existed in the variables studied between serial premolar extraction subjects and subjects at post-retention. This included no gender differences. No predictors of long-term change were of clinical value. In subjects where the serial extractions were followed by orthodontic fixed appliance treatment there appeared to be a greater increase in long-term lower incisor irregularity and crowding.

CONCLUSIONS: Long-term mandibular incisor irregularity was independent of serial premolar extraction treatment, and occurred to the same degree in a group of untreated subjects. Moreover, mechanotherapy appears to play a major role in the post-treatment dental changes.

61 CONTEMPORARY ORTHODONTIC TREATMENT—THE FACE AS A DETERMINANT OF TREATMENT CHOICE

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KEYNOTE ADDRESS

Computer imaging can alter the very focus of orthodontic treatment planning. The use of computers to converse and plan with the patient changes the focus of planning from primarily a dental view to a greater emphasis on the face and the impact of treatment on the face in all dimensions.

The aim of this presentation is designed to expand diagnostic vision and demonstrate how graphic imaging facilitates treatment decisions by clear visualization of objectives and interaction with the patient in terms the patient can understand. The utilization of computers for streamlining information management and direction of treatment mechanics will

be presented together with numerous clinical case illustrations. How this direction of decision making can affect orthodontic treatment planning will be present.

62 BIOMECHANICAL EVALUATIONS OF PALATAL IMPLANTS AND CONSEQUENCES FOR ORTHODONTIC ANCHORAGE

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AIM: To assess the distribution of bone tension and stretching with the finite element method (FEM) while loading palatal implants with different orthodontic forces.

MATERIAL AND METHOD: For improved understanding of biomechanics in endosteal palatal implants pilot calculations were carried out using the FEM. The task was to include clinical observations and microscopic examinations into model biomechanical calculations. In some cases a mesial tipping of the anchorage unit was registered. Observations of borderline cases were undertaken independent of the amount of bone deposition on the surface of explanted implants. The first model calculation related to totally osseointegrated implants (corticalis: $E = 2000 \text{ N/mm}^2$, spongiosa: $E = 500 \text{ N/mm}^2$, no connective tissue). The second model calculation hypothetically assumed connective tissue around the implants with a thickness of 0.2 mm (corticalis: $E = 2000 \text{ N/mm}^2$, spongiosa: $E = 200 \text{ N/mm}^2$, connective tissue: contact elements, which transmit only pressure, frictional value = 0.1). The model calculations were carried out with different force directions versus implant axis (0–90 degrees) respectively, subdivided in cases with full bonding of all teeth and with movement of a single tooth.

CONCLUSION: The FEM characterises the loading of implants with different orthodontic forces.

This study was supported by the Danish Dental Association and the John and Birthe Meyer Foundation.

63 THREE-DIMENSIONAL RECORDS OF MOVEMENTS OF THE MANDIBLE AND CHANGES OF NEUROMUSCULAR GUIDANCE AS RESULT OF COMBINED ORTHODONTIC-SURGICAL TREATMENT

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AIM: To examine whether adult patients with mandibular retrognathism combined with a dental Class II relationship show a characteristic structure of mandibular movements

caused by the neuromuscular system compared with patients with neutral skeletal and dental relationships. The second aim was to investigate whether these characteristic structures are subject to change following orthodontic-surgical treatment.

SUBJECTS AND METHODS: In order to record three-dimensional (3D) movements of the whole mandible, an ultrasonic device was chosen and computer software was developed for the analysis. The patients were asked to perform plane mandibular movements along the borders of its space of motion and only pure plane movements were taken for analysis. The movement of the entire mandible can be described by simultaneous rotations around two axes: the fixed maxillary axis Max A and the moveable mandibular axis Mand A. They are neuromuscularly guided and are called 'neuromuscular axes'. For graphic presentation of the movements of the individual mandible, the rotational angle 'my' was used, which represents the rotation around Max A, and angle 'alpha', which is the rotational angle of the mandible with respect to the maxilla. The study contained my-alpha-diagrams of a group of adult patients with mandibular retrognathism combined with a Class II relationship ($n = 40$). Movements of the whole mandible were first analysed following pre-surgical orthodontic treatment. Orthognathic surgery was carried out as a sagittal split ramus osteotomy with a condylar positioning technique. The same patients were examined again approximately 1 year after the end of the post-surgical orthodontic treatment. The data were compared with my-alpha diagrams of patients with neutral skeletal and dental relationships ($n = 40$).

RESULTS: From the pre-surgery my-alpha-diagrams it could be seen that the structure of mandibular movements was significantly different compared with patients with neutral skeletal and dental relationships. In the my-alpha-diagrams after combined orthodontic-surgical-treatment, the patients showed a nearly ideal diagram resembling that of subjects with neutral skeletal and dental relation.

CONCLUSIONS: Individual cases and statistical data show that the structure of mandibular movements can only be detected with 3D-records. The structure of movements of patients with mandibular retrognathism combined with dental Class II relationships differs from that in subjects with neutral alignment. Following orthodontic-surgical treatment, the examined patients showed a similar pattern in the structure of mandibular movements to those with no disturbances and neutral skeletal and dental relationships.

64 ORTHODONTIC ASPECTS ON THE USE OF DENTAL IMPLANTS IN ADOLESCENTS: A FOLLOW-UP STUDY

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KEYNOTE ADDRESS

AIM: There is an increasing need for more information concerning the use of oral implants in young individuals; whether they should be used at all and, if so, how and when.

This lecture will discuss experiences from a 10-year follow-up study:

SUBJECTS: Fifteen adolescents with a total of 27 oral implants inserted at the chronological age of 13–17 years.

RESULTS: These have clearly shown that a fixed chronological age is no guidance for implant placement. A dental stage, indicating fully erupted permanent teeth and skeletal maturation, completed or almost completed, is not sufficient to avoid infraocclusion of the implant-supported crown, due to a slight continuous eruption of the adjacent teeth post-adolescence. Throughout the follow-up period, only minor loss of marginal bone support was observed at the implants. The teeth adjacent to the implants showed, in some patients, a reduction of the marginal bone level.

CONCLUSION: Orthodontic treatment should be performed not only to gain space in the implant area by uprighting the adjacent teeth by non-intrusive tooth movements, but also to attain good occlusal stability to reduce the risk of infraocclusion of the implant-supported crown, which is of special importance in the upper incisor region.

65 EARLY VERSUS LATE TREATMENT FOR CLASS II MALOCCLUSIONS

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KEYNOTE ADDRESS

AIM: To compare orthodontic treatment for Class II malocclusions started in the mixed or permanent dentition.

SUBJECTS AND METHOD: One hundred and sixty-six preadolescent children (≥ 1 year prior to their peak growth velocity) with an overjet ≥ 7 mm, were randomly assigned either to early growth modification with headgear ($n = 52$) or modified bionator ($n = 53$), or to observation only until the permanent dentition was established ($n = 61$). The treatment outcome (skeletal, dental and oral health effects) were compared at 15 months (the end of Phase 1 of the trial: $n = 166$), after any necessary additional treatment (end of Phase 2: $n = 138$ and after 1 year of post-treatment follow-up ($n = 99$)).

RESULTS: There was wide variation in the Phase 1 treatment response. Both headgear and modified bionator resulted in small but statistically significant differential maxillary and mandibular growth effects. No predictable influences on the magnitude of this skeletal change could be determined. Subsequent treatment resulted in no differences between the groups in terms of final skeletal or occlusal relationships or health measures. The treatment complexity measured as extraction and surgical correction rate was not different between the groups. However, the time in fixed appliances was, on average, shorter for children who had had early treatment as compared with those for whom treatment was delayed. These differences were small (7 months for bionator, 5 months for the headgear). There appear to be no differences in treatment outcome between the three groups at 1 year follow-up.

CONCLUSIONS: Small but significant differential growth effects can be effected for preadolescent Class II patients. However, two phase treatment is likely to increase the total treatment time, with little difference in the skeletal or occlusal results between early and delayed treatment groups.

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66 FACIAL GROWTH IN GROWTH HORMONE DEFICIENT CHILDREN STUDIED BY THREE-DIMENSIONAL CEPHALOMETRY
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AIM: To improve the reliability of a three-dimensional (3D) tool for assessing the osseous and muscular features of facial growth in growth hormone (GH) deficient children undergoing hormonal treatment.

SUBJECTS: The sample comprised 19 GH-deficient children who presented intrauterine growth retardation and one child affected by achondroplasia. At the beginning of treatment, their mean age was 10 years and mean height -2 DS.

METHODS: General clinical measurements (length of superior and inferior segments, osseous diameters, muscular perimeters) were obtained at the beginning of treatment. A craniofacial scanner was then used before the start of therapy. On the axial slices eight landmarks of Treil's construction and several trigeminal points were marked. A contouring tool of the C2000® software (Cirad, Montpellier, France) was used in order to demarcate the limits of the right masseter muscle and the borders of facial fat. Six months after the start of therapy, a second examination was carried out and craniofacial computed tomography (CT) was performed. The data of this study consisted of the general clinical measurements and the biological values collected at the two examinations and the computed data from the CT scans. All the families gave informed consent and the protocol of the study was submitted to an ethical board.

RESULTS: The mandibular floor was the most positively influenced and the ramus and corpus lengths were significantly increased. The nasomaxillary floor grew to a lesser extent. The widening of the cranial base was one of the noteworthy observations of this work. The individual efficiency of GH therapy on osseous measurements was well correlated to its effects on biological values. The muscle volume increased between 12 and 16 per cent while the fat volume decreased between 13 and 40 per cent.

CONCLUSION: The main result is the assessment three-dimensionally of transversal facial growth that cannot easily be described by 2D conventional cephalometry. The influence of the masseter muscle on facial growth and the effects of GH therapy on muscle/fat ratio were also highlighted.

67 ORTHODONTIC EDUCATION AND INNOVATIVE TECHNOLOGY: A PROJECT INVOLVING FOUR UNIVERSITIES

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OrthODL (Open Distance Learning Co-operation for European Postgraduate Education and Training in Orthodontics, EU Socrates project 25163-CP-1-96-1-NO-ODL) is building a database system consisting of complete records of orthodontically treated patients. The 'OrthoLINE' database system, accessible via the Web, is to be used mainly by postgraduate students for case-based self-learning and by instructors for teaching.

'OrthoLINE' is a result of common work of orthodontists, mostly faculty members at the Departments of Orthodontics at four universities—partners in OrthODL. During the past 3 years the partnership has been through all the steps necessary to develop this common, distant-access, standardized record system. Furthermore, the system had to become an essential element of the partners' postgraduate and continuing education efforts, serve as the basis for Open and Distance Learning in Orthodontics, as well as guarantee its own continuous enrichment, expansion and updating.

The specialty course in orthodontics in Bergen was chosen for the first, pilot implementation. During the implementation phase the impact of information and communication technology on students and instructors has been monitored as well as the difficulties encountered with the new curriculum. A related EU-Leonardo project (North-South) is evaluating the use of OrthoLINE for pilot communications and case discussions among professional orthodontists across Europe. This presentation will give details of the web-based system itself, the educational benefit stemming from its use, and the standards and procedures necessary for the integration of the system into a unique (one patient-one record) electronic patient record system.

68 TISSUE REACTION TO ORTHODONTIC TOOTH MOVEMENT IN DIFFERENT METABOLIC CONDITIONS

C Verna, Department of Orthodontics, Royal Dental College, Aarhus University, Denmark

AIM: To determine whether high or low bone turnover influences tissue reactions to orthodontic tooth movement. **MATERIAL:** Fifty-two 6-month-old male Wistar rats divided into: normal (Group 1), high (Group 2) and low (Group 3) bone turnover.

METHODS: Hyper- and hypo-thyroidism was induced pharmacologically in Groups 2 and 3. The upper left first molar was moved mesially for 3 weeks with a 25 g Sentalloy coil spring in all rats, who received intravital staining 7 and 2 days before sacrifice, respectively. On transverse thin sections the surface area of the alveolar socket (ASA), of the

PDL (PDLA), erosion surfaces (ES/BS) and mineralizing surfaces (MS/BS) were measured on the treated and untreated sides, at a coronal (A) and apical (B) level and on the mesial and distal sites. Wilcoxon and Mann-Whitney tests were performed.

RESULTS: The main differences between and within turnover groups were localized coronally. ASA, PDLA, ES/BS and MS/BS were larger on the treated than on the untreated side in all three groups, except for MS/BS in Group 2. The level of bone turnover had an impact on the reaction to the mechanical load, as the difference between treated and control sides of ASA and PDLA was larger in Group 2 than in Group 1, and both were larger than Group 3. The difference between the treated and untreated side of ES/BS on the mesial side was larger in Groups 1 and 2 than in Group 3, while for MS/BS it was, compared with Group 2, on the mesial site at level A, significantly larger in Groups 1 and 3.

CONCLUSION: The high turnover group showed the highest levels of resorption and the lowest level of bone formation in the direction of the force. This may suggest a higher risk of alveolar bone dehiscence in patients with this metabolic condition. The reactivation of the appliance in patients with a high metabolic rate can be performed more frequently than in normal and low turnover patients, and *vice versa*.

69 IMPLANTS FOR ORTHODONTIC ANCHORAGE

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AIM: To illustrate some aspects of orthodontic-prosthetic and purely orthodontic implant anchorage by means of clinical cases, studies and experimental results.

MATERIAL AND RESULTS: Different types of osseointegrated prosthetic implants were successfully used for orthodontic-prosthetic implant anchorage in partially edentulous patients to correct malocclusions. This will be demonstrated by clinical cases. Characteristics of these implants are: large dimensions, horizontal and/or vertical loading with continuous forces up to 3N and favourable implant length to lever arm ratio. Previous experimental results in dogs during and after long-term orthodontic load to screw-type prosthetic implants revealed: positional stability, an increased amount of peri-implant remodelling, a higher amount of direct bone contact at the interface, and even marginal bone apposition.

In purely orthodontic patients these relatively large implants inserted into the alveolar bone were not suitable for anchorage purposes because either a full dentition was present or extraction sites were to be closed. To overcome the intra-arch space problem, diameter and/or length reduced implants were inserted into the interdental septum, supra-apical region, retromolar or palatal area. By means of palatal implant supported orthodontic anchorage (implant lengths: 4 or 6 mm, one-stage surgery) different treatment facilities

will be presented. Implant specific, biomechanical and biological factors which resulted in a successful clinical application will be described: e.g. positional stability despite an unfavourable implant length to lever arm ratio, forces and moments acting on the desmodontal-osseous anchorage units, and force distribution within the peri-implant bone, as implants have no centre of resistance.

CONCLUSION: Implant-based orthodontic anchorage enlarges the therapeutic spectrum and allows a rigid, compliance-free, intraoral anchorage preparation. Successful application of this method however requires a comprehensive knowledge of surgical, periodontal and biomechanical aspects relating to both oral implants and orthodontics.

70 EXTERNAL ROOT RESORPTION AS A REACTION TO CONSTANT AND DISSIPATING FORCES

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AIM: To determine whether constant orthodontic forces cause more severe root resorption than dissipating forces.

MATERIAL: Nine premolars from 27 individuals (mean age 12.5 years).

METHODS: Before starting the experiment six premolars were extracted and used as control teeth. Two groups of 42 premolars (84 teeth in total) were moved. Using a fixed orthodontic appliance the experimental premolar on the one side was moved buccally with a superelastic archwire activated to 4.5 mm (force level 0.8–1 N). The contralateral premolar was activated with a stainless steel archwire (activation 1 mm). The experiment lasted 12 weeks. The superelastic archwire was not adjusted during this period, whereas the steel wire was readjusted to a 1 mm offset every 4 weeks. Casts were made immediately before and at the end of the experimental period. After extraction the teeth were rendered inorganic. The resorption lacunae were mapped three-dimensionally using confocal laser scanning microscopy. After digital reconstruction of the root contour the depth, perimeter, area and volume of the resorption lacunae were registered. Statistical analysis (Wilcoxon's matched pairs signed-rank test, Spearman test) was performed.

RESULTS: The depth of the resorption lacunae did not differ between the groups (median 270 μ m). The median sum per root of the perimeter ($1.8 \times 10^4 \mu$ m in the 'steel'-group versus $4.4 \times 10^4 \mu$ m in the 'superelastic'-group), area (1.1×10^6 versus $2.6 \times 10^6 \mu$ m) and volume (1.9×10^9 versus $4.5 \times 10^9 \mu$ m) of the lacunae differed to a highly significant extent. The differing amount of tooth movement in the two groups accounted for 12 per cent of the variation in resorption. Large individual variations were found in both groups.

CONCLUSION: Superelastic forces seem to cause more pronounced root resorption activity when compared with dissipating forces delivered by stainless steel archwires.

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71 CLINICAL AND GENETIC STUDIES OF VAN DER WOUDE SYNDROME

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AIMS: Clinical and genetic analysis of Swedish patients with van der Woude syndrome (VWS), the most common syndromic form of cleft lip and palate.

SUBJECTS: A search was performed in the cleft lip and palate patient registry of the Stockholm region to identify VWS cases. Two Swedish VWS families (nine affected and 20 unaffected) and two sporadic VWS patients with their unaffected family members were identified and recruited. Polymorphic microsatellite markers from chromosome 1q32 (D1S245, D1S471, D1S491, D1S205 and D1S31753) were used for genetic analysis.

METHODS: Clinical examination was performed on the VWS patients and their family members. Blood samples were obtained, DNA extracted and PCR (polymerase chain reaction) performed. Electrophoresis was carried out on an ABI 377 sequencer. Two-point linkage analysis was performed using the MLINK program (Linkage 5.1). Micro-deletion was analysed by alleotyping.

RESULTS: Clinical variation (intra- and inter-familial) was observed in VWS patients ranging from hypodontia to lip pits, cleft lip or cleft palate. Linkage analysis of the two VWS families yielded a maximum LOD (logarithm of odds) score of 3.75 ($\theta = 0$) using the combined haplotypes of D1S491 and D1S205. No constitutional deletion was detected from either the sporadic or the familial VWS patients.

CONCLUSION: Clinical manifestation of VWS can be variable even within the same family. The Swedish VWS families are linked to the chromosome 1q32 region flanked by markers D1S491 and D1S205. The importance of both clinical and genetic aspects of VWS to orthodontists will be discussed together with the implication on predictive testing and future preventive measures.

72 IS SCOLIOSIS A RISK FACTOR IN THE DEVELOPMENT OF LATERAL CROSSBITES?

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AIM: To determine the prevalence of lateral crossbites in children affected by scoliosis.

SUBJECTS: Forty-three subjects with the most severe lateral deviations (Cobb angle > 25 degrees) from a cohort of 150 patients referred to an orthopaedic surgeon.

METHODS: Antero-posterior radiographs of the vertebral column and, retrospectively, collected data files from dental clinics.

RESULTS: There was a significantly higher prevalence of lateral crossbites among the scoliotic subjects (26 per cent)

than among Swedish pre-school children in general (11–17 per cent). There was also an over-representation of subjects with a Class II molar relationship (26 per cent) and a remarkably high frequency of tooth germ aplasia (14 per cent). All unilateral aplasias occurred on the contralateral side of the scoliotic curve.

CONCLUSION: Early screening for lateral curvatures of the spine is important in preventing development of lateral malocclusions. A high frequency of tooth aplasia in association with scoliosis has been reported earlier (Huggare *et al.*, 1991) which arouses attention to a possible common aetiology. Scoliosis might be the first sign of lesions in the brain stem, and spinal cord (Samuelsson and Lindell, 1995), the early embryonic development of which is essential for tooth formation (Christensen *et al.*, 1993).

73 MODEL-BASED COMPUTER VISION FOR SUPERVISED LANDMARKING OF CEPHALOGRAMS

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AIM: To define computer-aided landmarking of cephalograms.

MATERIAL: Forty randomly selected, digitized lateral cephalograms.

METHODS: The system was implemented on a medium range personal computer (Pentium 200). The cephalograms were digitized using a desktop scanner at a resolution of 100 dpi. The supervised approach followed in this research was to ask the user to first estimate the landmark location: the system then used these estimates to fit models to the considered landmarks. Fifteen cephalograms were used to build models and 25 were then used to test these models. The landmarks were Sella, Na, B, Pog and Me. The manual estimates of landmark position needed for the process were set randomly within 2–5 mm of the actual landmark position.

RESULTS: The final errors, i.e. the distance between manual and automated landmarking was similar to that reported for intra-observer errors. Moreover, the system gave reproducible results, i.e. same final model fitting with different initial manual estimates. The impact of these errors on the cephalometric measurements varied significantly depending on the measurements' definition: typically, variations of several millimetres in the placement of Pog on the outline of the bony chin had virtually no impact (<0.5 degrees) on the S-N-Pog angle.

CONCLUSIONS: The extensive literature on cephalometric methods highlights the various sources of errors in the method (identification of landmarks, subjectivity in interpretation of landmarks and positional repeatability of human experts). The main improvement a computer system can bring is reproducibility of the analysis. The actual accuracy of the system is mainly dependent on the definition of landmarks and measurements.