

ABSTRACTS

OF LECTURES

(Poster presentations will appear in the October issue of the Journal)

EUROPEAN ORTHODONTIC SOCIETY

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1 POST-ORTHODONTIC STABILITY

T Aasen, Private Practice, Skien, Norway

AIM: To treat lower dental arch stability by following the biological principles and known procedures during treatment and use Little's irregularity index as a measure for stability.

SUBJECTS AND METHODS: Sixty-seven subjects from a total of 71 consecutively treated patients who attended for records three years after removal of all fixed appliances. The upper arch was retained with a plate for approximately 1.5 years. No retention was used in the lower arch. Of the 67 patients, 12 started treatment before full eruption of the lower canines and were excluded from the study, resulting in a total of 55 subjects. During treatment care was taken not to expand the frontal area or to procline the lower incisors; the intercanine distance was decreased, rotated teeth were overcorrected in the opposite direction about the same amount as the original rotation and then moved back to the correct position. Stripping, interproximal enamel reduction from the mesial surface of the canines, including the incisors, was performed in all cases. Class II elastics were not used during treatment.

RESULTS: The mean intercanine distance and irregularity index were: pre-treatment, 26.25 and 25.70 mm; post-treatment, 25.09 and 5.55 mm; three years post-treatment, 0.42 and 1.06 mm, respectively. The mean stripping was 1.51 mm. In 20 subjects the canines were positioned with slight mesio-lingual rotations, which increased the mean post-treatment irregularity index. The irregularity index was 1 mm or less in 32 of the 55 patients.

CONCLUSION: It seems possible to achieve acceptable post-treatment stability over a period of three years, but it is necessary to separate between post-orthodontic relapse and later developmental changes over an extended period of time.

2 EVALUATION OF THE RELATIONSHIP BETWEEN THE ANTERIOR COMPONENT OF OCCLUSAL FORCE AND POST-RETENTION CROWDING

A Acar, T Alcan, N Erverdi, Department of Orthodontics, Marmara University, İstanbul, Turkey

AIM: To investigate whether a relationship exists between the anterior component of occlusal force (ACF) and post-retention crowding in the lower incisor area.

SUBJECTS AND METHOD: Thirty-two adult individuals who had undergone fixed orthodontic treatment. In 13 subjects the lower arch was treated non-extraction while in 19 subjects bilateral first premolar extractions were carried out. The average post-retention period was 3.5 years. ACF created on the left side of the lower dentition was determined by measuring interdental frictional forces at each contact point mesial to the first molar and distal to the canine. This procedure was performed first when the subject was not

biting and then repeated when the subject was simultaneously biting on a bite force transducer placed between the upper and lower left second molars. Anatomical contact point displacements between the left mandibular anterior teeth (2-3, 1-2, and 1-1) were measured on plaster casts and summed to provide the Irregularity Index. Correlation analysis was used to assess the relationship between ACF values at each contact and the Irregularity Index.

RESULTS: In the non-extraction group, significant positive correlations were observed between ACF and the Irregularity Index at all three measured contact points. The strongest correlation was found at the 3-4 contact ($r = 0.659$). In the extraction group, a weak correlation was found between ACF and the Irregularity Index ($r = 0.49$, $P < 0.05$) at the 5-6 contact, while no correlation was found at the 3-5 contact.

CONCLUSION: There is a moderate positive correlation between ACF and post-retention lower arch crowding in non-extraction cases.

3 THE QUALITY OF THE STEINER DIAGNOSTIC PREDICTION ANALYSIS

R T Al Beirouty, A M Kuijpers-Jagtman, C Katsaros, Department of Orthodontics and Oral Biology, University of Nijmegen, The Netherlands

AIM: To study the accuracy and precision of the Steiner diagnostic prediction analysis on lateral cephalometric radiographs.

SUBJECTS AND METHODS: Two hundred and seventy-five patients orthodontically treated between 1970 and 1995. To exclude substandard treatment outcome as a possible reason for failure of the prediction; only cases with good treatment results were included (over 70% improvement of the Peer Assessment Rating index). Lateral cephalometric radiographs before (BB) and after active treatment (BR) were analysed using the Steiner analysis. Steiner prediction analysis (PV) concerning the variables ANB°, UI to NA mm, LI to NB mm and Pg to NB mm was performed prior to active treatment. The difference between the real achieved BR value and PV value was calculated. Accuracy (mean difference between BR and PV) and precision (standard deviation of the difference) of the prediction were studied. A paired *t*-test was used to detect under- or overestimation of the predicted values.

RESULTS: The mean decrease in angle ANB was -1.23 ± 2.43 degrees and for UI to NA -2.03 ± 2.59 mm, while LI to NB and Pg to NB increased (0.82 ± 1.97 and 0.70 ± 1.09 mm, respectively). The changes achieved by treatment in the ANB angle, the distance of the upper incisor UI to NA, as well as the distance of the lower incisor LI to NB, were significantly overestimated as compared with the prediction, while the distance of Pg to NB was underestimated.

CONCLUSION: The prediction of cephalometric changes that can be reached by orthodontic treatment is not sufficiently accurate to make treatment decisions.

4 PREDICTING PROLONGED PAIN EXPERIENCES DURING AN ORTHODONTIC PROCEDURE

M Bergius, U Berggren, A G Broberg, Departments of Orthodontics, Oral Diagnosis, and Psychology, Göteborg University, Sweden

AIM: To investigate pain experiences during a common orthodontic treatment procedure with regard to concomitant factors such as motivation, general pain perceptions, and pain medication.

SUBJECTS AND METHODS: Fifty-five patients (12–18 years of age; 32 females, 23 males) starting treatment due to crowding. After baseline assessment of motivation, temperament, self-concept, dental anxiety, and perceptions of general and dental pain, molar elastic separators were inserted bilaterally. Telephone interviews, including assessment of pain intensity and pain medication, were made during the evening for one week and the answers registered on a visual analogue scale (VAS).

RESULTS: Pain was frequent (95%) and peaked at day 2 (VAS mean = 43.7). Patients taking pain medication made significantly higher pain ratings, while motivation had a marginal influence. At day 7, 42 per cent still reported pain and girls made significantly higher pain ratings during the later phase (day 3–7) of the follow-up week. Pairwise comparisons between individuals with and without reported pain at day 7 revealed significant differences with regard to gender, dental anxiety, perceived pain from vaccinations, and the dental explorer. These individuals also made higher pain assessments during days 1–5. A preliminary regression analysis of pain assessments at day 7 indicated that late pain experience was predicted by dental anxiety, general pain perceptions, and temperament and self-concept factors.

CONCLUSIONS: Pain is common after a simple procedure such as placement of molar separators. The intensity of pain gradually reduced, but still more than 40 per cent of the investigated group reported some pain after one week. Late pain experiences were predicted by personality factors, dental anxiety, and reactions to pain in general.

This study was supported by the Swedish Dental Society.

5 *IN VITRO* DEBONDING CHARACTERISTICS OF CERAMIC BRACKETS ON TWO DIFFERENT CERAMIC SURFACES

D Bister¹, D Young¹, M Sherriff², Departments of ¹Orthodontics and Paediatric Dentistry and ²Material Sciences, GKT Dental Institute, Guy's Hospital, London, England

AIMS: To assess the influence of four different bonding techniques on shear bond strength on two different ceramic surfaces. Two different methods were used for composite removal and three methods for surface finishing.

MATERIALS AND METHODS: APC precoated Clarity brackets (3M Unitek) were bonded to two ceramic surfaces, Vita α (Vita, Germany), used for jacket crowns, and Creation

(Klema, Austria), used for ceramic fused to metal restorations using the following techniques ($n = 10$): Group 1, no preparation; Group 2, sandblasting (50 μm Al_2O_3); Group 3, etch [9.6% HF (hydrofluoric acid)]; Group 4, sandblasting and etching. The surfaces were then primed with a silane coupling agent (90 seconds) and Transbond (3M Unitek) primer. Shear bond strength was tested using an Instron testing machine and the surfaces inspected using light and scanning electron microscopy. Residual composite was removed with a tungsten carbide bur (slow or high speed). The surfaces were further finished with a felt wheel (pumice or diamond paste) or diamond-impregnated rubber points. **RESULTS:** Group/shear bond strength in N (mean and SD)/site of failure (ceramic/composite/bracket):

Vita α

1	75.6 (27.2)	0/10/0
2	106.4 (11.9)	1/9/0
3	101.5 (17.1)	1/8/1
4	105.4 (15.2)	4/6/0

Creation

1	70.7 (29.3)	1/9/0
2	92.5 (22.9)	0/10/0
3	94.5 (23.7)	1/9/0
4	105.8 (15.8)	4/6/0

CONCLUSIONS: Bond strength is not directly associated with bracket failure on the ceramic (crown) surface, but rather with the type of surface preparation. Sandblasting/HF shows the highest failure rate. Vita α shows slightly increased bond strength over Creation. Tungsten carbide burs on slow speed handpieces should be avoided for composite removal as crack propagation occurs. Using either diamond-impregnated rubber points, pumice, or diamond paste on felt wheels for surface restoration produces clinically acceptable finishes.

6 VECTOR ANALYSIS OF TEMPOROMANDIBULAR JOINT MUSCULAR LOADING IN DIVERSE CRANIOFACIAL SKELETAL PATTERNS

P Bracco, A Castiglia, P Richiardi, Department of Clinical Physiopathology, Section of Orthodontics-Gnathology-Masticatory Function, Turin University, Italy

AIM: To investigate loading of the temporomandibular joint (TMJ) in different craniofacial patterns using a specially developed two-dimensional mathematical model of the human mandible, including its articulating surfaces and the forces exerted by the primary masticatory muscles (masseter and temporalis).

SUBJECTS AND METHOD: Sixty-one subjects, with an age range between 18 and 30 years, underwent different diagnostic trials, electromyographic and conventional radiography, in order to obtain the cephalometric evaluation

of the skeletal typology. After reviewing both the test responses from the 61 individuals and from the experimental model, the results were compared.

RESULTS: Different craniofacial structures can influence the TMJ by variation in muscular mechanical advantage and of jaw lever system conditions. Vector variations of the jaw lever system concerning the direction of TMJ reaction forces were less significant than intensity. Varying skeletal type from hypodivergent skeletal deep bite to hyperdivergent skeletal open bite, the jaw muscle orientation and moment arms were different. In hypodivergent subjects the medium ratio between masseter force intensity and temporal-force intensity during clenching was greater than the same ratio in hyperdivergent subjects. In hyperdivergent subjects, the corner value between TMJ vector direction and vertical reference line was slightly higher.

CONCLUSIONS: The jaw lever system conditions and the nature of stress distributions in the TMJ were significantly affected by vertical discrepancies of the craniofacial skeleton. It also suggests that these changes in stress increase the risk of lacking biomechanical equilibrium in the TMJ, which may have some association with temporomandibular dysfunction.

7 THE CHOICE BETWEEN ORTHODONTIC AND SURGERY IN BORDERLINE CASES

R Brusati, Department of Maxillo Facial Surgery, Hospital S. Paolo, University of Milano, Italy

KEYNOTE ADDRESS

It is universally accepted that the aim of orthodontic or surgical-orthodontic treatment is to establish a stable, ideal occlusion with neuromuscular equilibrium and good facial aesthetics. To achieve this goal, certain dentofacial deformities can be treated by orthodontic therapy alone while other cases will require surgical-orthodontic treatment. However, there also exist many clinical situations in which this treatment decision is not so obvious. It is clear that surgery in association with orthodontic therapy will result in ideal facial aesthetics and these results can be obtained more rapidly than with non-surgical methods. But we cannot forget that surgery has inherent risks, and that the aesthetic motivation of the surgeon may not be shared by each individual patient. Accurate and impartial information must be relayed by the surgeon and the orthodontist to the patient so that informed consent can be obtained and the patient can choose between the two modes of therapy knowing that this decision is irreversible.

8 SPECIFIC TEMPOROMANDIBULAR JOINT FINDINGS IN YOUNG PATIENTS PRIOR TO ORTHODONTIC TREATMENT

A Bumann, S Brix, K Wiemer, Meoclinic, Berlin, Germany, Department of Orthodontics, University of Southern California, Los Angeles, USA and Department of Experimental Dentistry, Free University Berlin, Germany

AIM: Historically, signs and symptoms of craniomandibular disorders have been diagnosed by questionnaires, by the

examination of active movements, and by palpation. However, these techniques are not suitable to diagnose compensated disorders, which are only detectable with passive examination techniques. This approach is important since compensated disorders may often be detected in a group of patients that enter the orthodontic office as 'healthy' patients, but may present a high risk for temporomandibular joint (TMJ) symptoms during treatment. Thus, the aim of this lecture is to present a 'routine examination protocol' based on manual orthopaedic examination techniques.

SUBJECTS AND METHODS: Seven hundred and fifty-nine children and adolescents aged 9–18 years (mean age 11.01 years; minimum 6 years, maximum 18.42 years). The condition of the TMJ soft tissues and the masticatory musculature was assessed by means of Manual Functional Analysis (MFA; active movements, orthopaedic joint loading tests, and isometric contractions). The examination was performed prior to orthodontic treatment. The clinical findings were rated as 'no pain' (physiological), 'provocable, unknown pain' (compensated disorders), and 'provocable, well known pain' (decompensated disorders). The intra- and inter-examiner reliability was tested with Cohen's Kappa coefficient. The incidence of positive findings for compensated and decompensated disorders was determined and the percentage for the different directions of overloading calculated.

RESULTS: The mean mouth opening was 50.8 mm. Prior to orthodontic treatment approximately 1 per cent of the children and adolescents showed decompensated disorders and approximately 18 per cent compensated disorders. The preferred directions of overloading were dorso-lateral and dorso-cranio-lateral in the bilaminar zone.

CONCLUSION: Given the high prevalence and incidence rates for compensated temporomandibular dysfunction in a young population, a systematic clinical screening with the MFA should be performed in all patients prior to orthodontic treatment.

9 PREDICTORS OF ROOT RESORPTION IN CLASS II DIVISION 1 MALOCCLUSIONS

D Burden, N McGuinness, M Stevenson, Queen's University, Belfast, Northern Ireland

AIM: The prevalence of root resorption experienced by patients with Class II division 1 malocclusions treated using a standard approach was studied using two radiographic techniques.

SUBJECTS AND METHOD: Four hundred and nine consecutively treated Caucasian patients with complete records who had a Class II division 1 malocclusion with an initial overjet greater than 6 mm. Pre- and post-treatment dental pantomograms (DPT) were used to rank the root length loss during treatment using the method reported by Sharpe *et al.* (1987). Pre- and post-treatment cephalograms were also used to measure directly the amount of root shortening that occurred in the upper central incisors during treatment.

RESULTS: Analysis of the DPT data only explained 7 per cent of the variation in root length. However, analysis of the cephalometric data explained 37 per cent of the variation. The significant covariates identified from the cephalometric recording method were: alveolus width (the wider the alveolus the greater the root resorption recorded, $t = -10.31$, $P < 0.001$); incisor apex to palatal cortex distance post-treatment (the greater the distance between the palatal cortex and the incisor apex post-treatment the less root resorption noted, $t = 11.64$, $P < 0.001$); incisor intrusion (the greater the incisor intrusion the more root resorption recorded, $t = -11.19$, $P < 0.001$); and time in rectangular archwires (the longer rectangular archwires were worn the less root resorption was recorded, $t = 3.07$, $P = 0.002$).

CONCLUSIONS: There is an increased risk of root resorption when incisors are intruded and their roots are moved closer to the palatal cortical plate.

10 AESTHETIC EVALUATION OF THE ANTERIOR LIMIT OF THE DENTITION—A PILOT STUDY

A C Butti¹, R Conconi¹, F Veglia², ¹Università degli studi di Milano and ²Institute of Scientific Interchange, Italy

AIM: To evaluate the aesthetic aspect of the anterior limit of the dentition (ALD), the judgements of different groups of observers were considered. The consistency of their judgements was also investigated.

MATERIALS AND METHODS: Four panels of observers (dentists, orthodontists, orthodontic residents, and laypeople) judged 90 slides showing lateral views of 80 smiling faces. Ten faces were displayed twice to determine consistency. The observers expressed their aesthetic judgement of the sagittal position of the upper incisors and marked on a scale the desired sagittal movement of the upper incisors to obtain a pleasant position. Data were statistically evaluated. The frequency of the variations occurring in the repeated face were also computed and arbitrarily subdivided in to three categories: 'negligible error' (0–1 mm), 'mild error' (2 mm), and 'great error' (> 2 mm).

RESULTS: (1) Consistency of judgements: differences among the four groups in judging repeated slides were not highly significant ($P < 0.02$). Negligible error ranged from 76 to 90 per cent. Laypeople showed the greatest errors and residents who were trained in this type of evaluation the smallest. (2) Co-variance analysis ($P < 0.001$) showed that the four panels asked for different movements of the ALD.

CONCLUSIONS: (1) The four panels showed a different consistency in evaluating the ALD and a 'learning' effect may be present since the trained observers (residents) achieved the highest degree of coherence. Photographic assessment of the ALD could be a reliable means to add useful data to plan a diagnosis, but further investigations are required. (2) The different ALD movement requested by the four groups could be due to a different capacity in foreseeing facial changes after incisor movement. It is possible that some profiles could be easier to evaluate than others.

11 CLINICAL COMPARISON BETWEEN A PLASMA ARC AND HALOGEN LIGHT FOR BRACKET BONDING

V Cacciafesta, M F Sfondrini, Department of Orthodontics, University of Pavia, Italy

AIM: To compare the 12-month clinical performance of brackets cured with either a halogen or a plasma arc light.

SUBJECTS AND METHODS: Eighty-three patients treated with fixed appliances were evaluated. Using a 'split-mouth' design, the mouth of each patient was divided into four quadrants. In 42 randomly selected patients, the maxillary left and mandibular right quadrants were cured with the halogen light and the remaining quadrants with the plasma arc light. In the other 41 patients the quadrants were inverted. One thousand four hundred and thirty-four stainless steel brackets (Victory, Unitek/3M) were examined: Fifty per cent were cured with a halogen light (Ortholux XT, Unitek/3M) for 20 seconds and the remaining 50 per cent with the plasma arc light (PAC, A. D. Technologies) for 5 seconds. After initial prophylaxis, the bonding procedure followed the manufacturer's guidelines. The enamel surface was etched with 37 per cent phosphoric acid for 30 seconds. After priming, each bracket was bonded with a composite resin (Transbond XT, Unitek/3M). The number, cause, and date of bracket failures were recorded for each light over 12 months. Statistical analysis was performed by means of a paired *t*-test.

RESULTS: No statistically significant differences ($P = 0.34$) were found between the total bond failure rate of the brackets cured with the halogen light (5.4%) and those cured with the plasma arc light (4.3%). Moreover, no statistically significant differences ($P > 0.05$) were reported between the percentage of failures of the two different lights when comparing the clinical performance of the upper and lower arch, as well as that of the anterior and posterior segment.

CONCLUSIONS: There is no significant difference between the percentage of failures of brackets cured with either a halogen or plasma arc light. Therefore, plasma arc lights can be considered an advantageous alternative to conventional light curing, because they enable the clinician to significantly reduce the curing time of orthodontic brackets, without affecting their bond failure rate.

12 VERTICAL AND SKELETAL CHANGES IN PATIENTS TREATED WITH LINGUAL APPLIANCES

M C Caniklioğlu, Y Öztürk, Department of Orthodontics, University of Istanbul, Turkey

AIM: To determine the vertical dentoskeletal changes induced by maxillary anterior bite planes in patients treated with fixed lingual orthodontic appliances.

SUBJECTS AND METHOD: Fourteen patients (11 females, three males) with deep bites specifically selected for lingual orthodontic treatment. Ormco 7th generation lingual brackets were indirectly bonded on both arches. The mean age at the beginning of treatment was 17 years 7 months and the average treatment time was 3.5 months. The mean

amount of overbite was 4.93 ± 1.79 mm. Lateral cephalometric radiographs were taken before treatment (T0), just after clinical bonding procedures (T1), and when posterior disclusion was completely closed (T2). The following measurements were taken in all subjects: skeletal parameters, SN-GoGn ($^{\circ}$), ANS-PNS/GoGn ($^{\circ}$), N-S-GN ($^{\circ}$), Na-Me (mm), ANS-ME (mm), S-Go (mm); dental parameters, U6-ANS-PNS (mm), UL-ANS-PNS (mm), L6-GoGn (mm), L1-GoGn (mm), UL-ANS-PNS ($^{\circ}$), L1-GoGn ($^{\circ}$). The means and standard deviations were calculated for each cephalometric variable, and paired *t*-tests were performed to assess the statistical significance of changes occurring during various time periods.

RESULTS: T0 to T1: statistically significant increases were found in all skeletal parameters. There were no significant changes in dental parameters except for overbite, which decreased significantly. T1 to T2: statistically significant decreases were found in all skeletal parameters. Among the dental parameters, increases in U6-ANS-PNS (mm), L6-GoGn (mm), and L1-GoGn ($^{\circ}$) were also significant. T0 to T2: statistically significant increases were found in all skeletal parameters. Among the dental parameters, increases in U6-ANS-PNS (mm), L6-GoGn (mm), L1-GoGn ($^{\circ}$), and the decrease in overbite were also statistically significant.

CONCLUSION: As a result of treatment overbite was corrected by lower molar extrusion ($P < 0.001$), upper molar extrusion ($P < 0.05$), and lower incisor protrusion ($P < 0.05$). All skeletal parameters were increased due to upper and lower molar extrusion.

13 EVALUATION OF SOFT TISSUE ADAPTATION DURING AND AFTER RAPID PALATAL EXPANSION

C Ceylanoglu, N Küçükkeleş, Department of Orthodontics, Marmara University, İstanbul, Turkey

AIM: To investigate the changes in pressures exerted on the maxilla by tongue, lips, and cheeks during rapid palatal expansion (RPE) and in the retention period.

SUBJECTS AND METHODS: Twelve patients (five males, seven females) with a mean age of 16.75 years with maxillary transverse deficiency. Maxillary expansion was carried out using a Hyrax device. Pressure measurements were made with a pressure transducer just before and immediately after expansion and at the end of the first, second, and third month of retention.

RESULTS: After expansion, pressures on the buccal surface of the upper first molar increased significantly during the rest position and swallowing (from 76.2 to 117.3 gr/cm²). The values started decreasing in the first month after RPE, and there was no difference between pre-expansion and third month values. On the lingual side of the molar, tongue pressure decreased following RPE during swallowing (from 183 to 124 gr/cm²). This decrease was not significantly low at the end of third month of retention, indicating that the

adaptation of the tongue required a longer period of time. Lip pressure on the incisor increased significantly following RPE (from 9.7 to 18 gr/cm²) and started decreasing after the first month, but the value was still significantly high at the end of the third month (13.5 gr/cm²). Tongue pressure on the upper incisor decreased significantly after RPE, but adapted by the end of the third month.

CONCLUSION: Following RPE, cheeks adapted at the third month while tongue pressure was still low even after the third month compared with the original values. This may be a possible cause of long-term relapse of rapid expansion.

14 DEVELOPMENT OF A QUALITY OF LIFE MEASURE FOR ORTHOGNATHIC PATIENTS

S J Cunningham, Eastman Dental Institute, University College London, England

AIMS: Assessment of health-related quality of life (HRQL) is becoming increasingly important and may be measured using two groups of instruments: generic and condition-specific. The purpose of this study was to develop a condition-specific measure for patients requesting orthognathic treatment (the Orthognathic Quality of Life Questionnaire; OQLQ) and to assess the reliability, validity, and responsiveness of the questionnaire.

MATERIALS AND METHODS: The OQLQ was developed in three stages: (1) item generation, followed interviews with 25 patients and 25 clinicians; (2) item reduction, involved 46 patients; and (3) instrument testing, involved 88 respondents. A principal component analysis (PCA) divided the instrument into domains, which were used in subsequent analyses. Reliability was established by assessing internal consistency and through the use of a test-retest study. Validity was tested by specifying expected levels of correlation between the four OQLQ domains and both the generic Short Form-36 (SF-36) health survey and a 100 mm visual analogue scale. The final step established responsiveness using longitudinal data before treatment (T1), following pre-surgical orthodontics/prior to surgery (T2), and six to eight weeks following debond (T3).

RESULTS: Reliability was shown to be acceptable with alpha coefficients for internal consistency between 0.83 and 0.93 and intra-class correlation coefficients for the test-retest in the range of 0.76 to 0.88. Validity testing confirmed that the majority of hypotheses were proven. Responsiveness testing showed no significant changes in HRQL between T1 and T2. However, three of the four domains showed significant improvements ($P < 0.01$) between T1/T3 and T2/T3.

CONCLUSIONS: The OQLQ has good evidence of reliability, validity, and responsiveness, and is now recommended for use in larger clinical trials. It was also found to be acceptable with respondents. The finding that quality of life is improved following treatment has important implications.

15 EFFECTS OF ORTHODONTIC FORCES ON PHYSICAL PROPERTIES OF ROOT CEMENTUM

M A Darendeliler, P Srivicharnkul, T Rex, Department of Orthodontics, University of Sydney, Australia

AIM: Root resorption, a concern in orthodontics, is a poorly understood phenomenon. Investigations of the physical properties of cementum may help in understanding any possible connection with the process of root resorption. This study aimed to evaluate hardness and elastic modulus of untreated human premolar cementum and investigate changes of hardness, elastic modulus, and mineral content of human premolar cementum after application of relatively light and heavy controlled orthodontic forces.

MATERIALS AND METHOD: Physical properties of human premolar cementum were investigated utilizing a new method to obtain a three-dimensional map with the use of the Ultra Micro-Indentation System (UMIS-2000). This enabled quantitative testing using nine untreated human premolars from apex to the cemento-enamel junction at 60 different sites to obtain baseline data. A further sample of 36 teeth from 17 patients (eight males, nine females, mean age 14.5 ± 1.4 years) requiring bilateral first premolar extraction for orthodontic treatment was collected, disinfected, and stored in Milli-Q. The patients were consecutively divided into two groups: light (25 g) or heavy (225 g) forces were applied to the right premolars using TMA (Ormco) springs (duration 4 weeks). Contralateral first premolars were used as controls. Speed brackets (Strite Industries) were used on the first premolars and molars to apply buccally directed forces. After extraction, 11 points on each tooth were tested. A total of 1980 indentations were performed. Paired *t*-tests and general linear models (ANOVA) were used for statistical analysis.

RESULTS: The hardness and elastic modulus of premolar cementum gradually decreased from the cervical to apical area, in the control and experimental groups. Calcium content was correlated with the hardness of the cementum.

CONCLUSION: The application of orthodontic force magnitude, either relatively light or heavy force, has no effect on the hardness and elastic modulus of human premolar cementum.

16 CHANGES IN FUTURE DIAGNOSIS AND TREATMENT PLANNING

L Dermaut, Department of Orthodontics, University of Ghent, Belgium

KEYNOTE ADDRESS

The diagnostic tools used by orthodontists around 1900 were limited to dental casts. During recent decades additional tools have become available which can be used to make a more complete orthodontic diagnosis and to establish an appropriate treatment plan.

There is no doubt that the introduction of computers has been of tremendous help in modern life. The same holds true

for its application in clinical orthodontics. Together with our patients we can sit in front of the computer screen and explain the diagnosis and treatment plan. Moreover it appears easy to forecast growth and treatment outcome. We can also write impressive reports with beautiful layouts to the general practitioners who refer their patients to our practices. We may impress them with all this technology.

A correct interpretation of all the information provided by these technological tools remains the major issue. There is a danger, however: that this technology may not establish the total and correct picture of the patient. It may also not lead to 'image building' of the orthodontist.

How about orthodontic dogma? Extraction of first premolars is expected to be the first choice in treatment planning in cases of bimaxillary protrusion. Does it mean that extraction of second premolars will result in a different facial appearance than after extraction of first premolars? How about long-term stability? This and other orthodontic dogmas will be discussed.

Co-operation and dental hygiene are the most common difficulties an orthodontist is faced with. The introduction of fluorides, chlorhexidine derivatives, and other drugs to protect the dentition and the surrounding structures against destruction might appear to be an important improvement in recent years. Might it not be better to put more emphasis on oral hygiene motivation than accepting a lack of co-operation and therefore introducing the routine use of drugs (rinses) during orthodontic therapy?

It is the purpose of this lecture to discuss the use and abuse of orthodontic diagnostic technology and to highlight and discuss some of the so-called dogmas.

17 ZYGOMATIC AND MANDIBULAR ANCHORS: A CLINICAL EVALUATION

H De Clerck¹, S Siciliano², M Delatte¹, Departments of ¹Orthodontics and ²Maxillo-facial Surgery, Catholic University of Louvain, Brussels, Belgium

AIM: To evaluate the stability of anchorage during orthodontic loading and the gingival health around the implants.

MATERIAL AND METHODS: Forty-nine zygoma anchors were placed in 33 patients. Thirty-five were used to distalize the canines and the anterior teeth after extraction of the first premolars. In non-extraction cases the lateral segment was distalized on 14 zygoma anchors. Before prosthetic restoration, eight second molars were uprighted using mandibular anchors. In extraction treatment a long power arm on the canine and coil springs of 100 g were used. Retraction of the anterior teeth was obtained with T-loop arches. In non-extraction treatment distalization of the molars was realized with open coil springs of 150 g or sliding jigs. The lower molars were uprighted with a 0.017×0.025 -inch TMA spring connected to the anchor. Mobility of the anchor and gingival health under different orthodontic loadings were studied.

RESULTS: Orthodontic reaction forces were transferred to the anchors over a mean period of 7.3 months ($\pm$ SD 2.9

months). Some mobility was usually noticed one month after surgery but decreased later. No radiolucency around the miniscrews was observed radiographically. The use of a round intra-oral extension considerably improved the oral hygiene and the gingival health around the anchors. No major infections were observed, except in one patient where one mandibular anchor was lost six weeks after surgery. One anchor was removed because of bad positioning and two at the demand of a patient.

CONCLUSION: Modification of the surgical technique and the design of the anchors improves gingival health, reduces discomfort for patients, and makes orthodontic application easier.

18 TWO- VERSUS THREE-DIMENSIONAL NON-INVASIVE ANALYSIS OF FACIAL SOFT-TISSUES IN 6-YEAR-OLD CHILDREN

F R Dimaggio, C Dellavia, V F Ferrario, Dipartimento di Anatomia Umana, Università di Milano, Italy

AIM: To verify whether a standardized photographic analysis allows reliable quantitative assessment of facial soft-tissues in 6-year-old children.

SUBJECTS AND METHODS: A standardized left-side facial photograph in natural head position was taken of 55 boys and 31 girls. Selected landmarks were digitised, and the following angles were calculated: facial convexity (N-Sn-Pg), maxillary prominence (Sn-N-Sl), facial convexity including the nose (N-Prn-Pg), nasal prominence (Sn-N-Prn), nasolabial (LS-Sn-Prn), mentolabial (LI-Sl-Pg), maxillo-labio-mandibular (Sn-LS^LI-Pg), interlabial (Sl-LI^Sn-LS). The three-dimensional (3D) equivalents of the same angles computed in 27 boys and 28 girls of the same age were obtained from Ferrario *et al.* (1999). Within each sex, mean values of two-dimensional (2D) and 3D angles were compared using the Watson-Williams' test, with significance set at 5 per cent.

RESULTS: In males, significant differences ($P < 0.05$) between 2D and 3D angles were found only for maxillary prominence and facial convexity, including the nose; in females only the Sn-LS^LI-Pg angle differed between 2D and 3D examinations. All the other angles gave similar results between the two imaging systems. The mean differences between 2D and 3D measurements were between 0.2 and 6 degrees.

CONCLUSIONS: In 6-year-old children, a simplified photographic analysis allows correct assessment of the sagittal arrangement of facial soft tissues, thus supplying an aesthetic analysis in early orthodontic treatment. A low-cost 2D measurement could thus be used as a first screening to assess treatment need. More refined non-invasive evaluations, as well as radiographic examinations, may be required in selected children.

Ferrario V F, Sforza C, Poggio C E, Schmitz J H 1999 Soft tissue morphometry from 6 years to adulthood: a three-dimensional study using a new modelling. *Journal of Plastic and Reconstructive Surgery* 103: 768-778

19 VARIATIONS OF INCISORS AND LIPS IN THE FACIAL PROFILE OF INDIVIDUALS WITH IDEAL OCCLUSION

G C Domínguez, J W Vigorito, Department of Orthodontics, University of São Paulo, Brazil

AIM: To determine the mean values of the cephalometric measurements nasion-perpendicular (NaPerp) and subnasale-perpendicular (SnPerp) of Brazilian white individuals with ideal occlusion and to compare them with the corresponding values of Epker and Fish's analysis.

MATERIAL AND METHOD: Lateral cephalometric radiographs of 30 white Brazilian individuals (15 males, 15 females) whose average age was 16 years 7 months $\pm$ 1 year 1 month, with an ideal occlusion and harmonious face. All radiographs were taken with the teeth in centric occlusion and the lips in the rest position. They were subsequently traced to determine the values describing: (1) dental and skeletal antero-posterior relationships with regard to NaPerp: A-NaPerp, B-NaPerp, A-B, pogonion-B and lower incisor-B; (2) the vertical relationship of the soft tissues with regard to SnPerp: glabella-subnasale:subnasale-menton (G-Sn:Sn-Me), subnasale-stomion (Sn-St), Sn-St:St-Me, subnasale-lower lip vermilion:lower lip vermilion-menton (Sn-LLV:LLV-Me), and interlabial distance; and (3) the horizontal relationship of the soft tissues with regard to SnPerp: upper lip-SnPerp, lower lip-SnPerp, and pogonion-SnPerp. Data were statistically analysed.

RESULTS: Normality mean values found were: A-NaPerp 2 ± 3 mm, B-NaPerp -1 ± 4 mm, A-B 3 ± 3 mm, Pog-B 1.5 ± 1.5 mm, lower incisor-B $3-7$ mm, G-Sn:Sn-Me 1:1, Sn-St 23 ± 2 mm, Sn-St:St-Me 1:2, Sn-LLV:LLV-Me 1:0.9, interlabial distance 0, upper lip-SnPerp 2 ± 2 mm, lower lip-SnPerp -1 ± 3 mm, and Pog-SnPerp -5 ± 5 mm.

CONCLUSION: Normality mean values in this group of Brazilian individuals are not substantially different from those found by Epker and Fish, with the exception of dental protrusion, a more prominent upper lip and soft tissue chin which was more retruded. These differences vary according to ethnic and racial differences as well as the generic concept of beauty to be obtained as an ideal treatment goal.

20 JUVENILE RHEUMATOID ARTHRITIS AND CRANIOMANDIBULAR DISORDERS: PREVENTION AND TREATMENT

G P Farronato, C Bellintani, F Santoro, Dental and Stomatological University Hospital of Milan, Italy

AIM: To prevent and treat the progressive evolution of juvenile rheumatoid arthritis (JRA) on craniofacial growth and morphology and particularly on the temporomandibular joints (TMJs). Involvement of the TMJs results from granulomatous alteration of the articular surface and disability of the joints. Radiographic findings include narrowed joint spaces, flattened condyles, erosions, subchondral sclerosis, cysts, and osteoporosis.

MATERIAL AND METHODS: Clinical and radiographic data of 62 JRA patients (49 males, 13 females) aged 6–16 years. Forty-nine of the subjects had a skeletal Class II malocclusion, 11 a skeletal Class I, and two were skeletal Class III. All had TMJ involvement and almost all a typical ‘bird face’ due to mandibular deficiency and post-rotation growth. A bimaxillary activator, suitably modified, was used to correct the characteristic tendency to the post-rotation growth of the mandible. This frees the joints reducing the load on the condyles, to preserve the TMJs from the proteolytic action of the enzymes released during chronic inflammation.

RESULTS: Almost all patients showed a satisfactory long-term result, with an improvement in the skeletal discrepancy and good restoration of TMJ function.

CONCLUSION: Early orthopaedic functional therapy controls progressive evolution of malocclusions in children affected with JRA, preventing exacerbation of mandibular posterior rotation.

21 DENTOSKELETAL CLASS III TREATMENT WITH SEC PROTOCOL

A Ferro, Naples, Italy

KEYNOTE ADDRESS

Dentoskeletal Class III malocclusions have long been the most difficult to correct. Although short-term results may be successful, these usually relapse in the long-term. There are more long-term relapsed cases than those remaining stable. Generally long-term stable cases show such a slight dentoskeletal disharmony or such a strong functional behaviour that dental/skeletal compensation (mandibular post-rotation) may be achieved.

In contrast, severe dentoskeletal Class III cannot be successfully treated by compensatory mechanics alone. These greatly increase the number of relapses. Dentoskeletal Class III is a hereditary disharmony with polygenic transmission, like other skeletal malocclusions. Unlike Class III, Class II are long-term stable. Thus the choice of treatment for Class III may be the reason for the relapse in the long-term.

This hypothesis can be tested by developing new therapeutic regimens with long follow-ups. A new protocol called SEC III (Splints, elastics chin cap III) has successfully been used to treat 52 dentoskeletal Class III subjects exhibiting an ANB angle less than 0 degrees or AOBO less than –2 mm. Long-term stability was found in 84 per cent of the treated patients and relapse in 11 per cent. When comparing stable and non-stable results, at the end of the active treatment, the stable cases showed improved skeletal correction and deeper OVB. At recall the relapsed cases had greater ramus growth. Because it is difficult to inhibit growth, at least clinically, a better correction of overbite could be useful to compensate and/or control ramus growth.

The SEC III protocol was thus modified by adding the occlusal vertical correction whereas it did not occur after the antero-posterior correction. The modified SEC III protocol suggests three steps for occlusal correction

(sagittal, vertical, and stabilization) with dental and skeletal movement.

The modified SEC III was successfully used on a sample of 30 patients consecutively treated for Class III malocclusions, who needed the vertical correction to reach a positive overbite after the antero-posterior correction.

22 LINGUAL ORTHODONTICS AS A REAL DAILY ALTERNATIVE

D Fillion

KEYNOTE ADDRESS

The lingual technique is a real daily alternative to treat adult patients since it is a non-visible appliance and its characteristics help in the treatment of some malocclusions faster than conventional appliances.

How to use the lingual appliance in a labial practice?

This lecture will focus on the necessary material, working, positioning, office organization, staff training, and difficult treatment procedures to make the use of the lingual technique as easy as conventional appliances.

The problems that a patient can experience during the adaptation period will be detailed and information to reduce initial patient discomfort will be provided.

The lingual technique is difficult, and experience and training are required to obtain excellent results. This lecture will also focus on the different ways to obtain efficient training in the lingual technique.

23 AXIAL INCLINATION OF MAXILLARY ANTERIOR TEETH ON COMPUTED TOMOGRAMS

J W Freudenthaler, A Gahleitner, K Drazdil, Department of Orthodontics, University of Vienna, Austria

AIM: To evaluate the inclination of the upper incisors, the canines, and the anterior maxillary dentoalveolar process on computed tomograms (CT).

SUBJECTS AND METHODS: Fifty-two patients (26 males, 26 females) with a mean age of 30.3 years referred for CT examination for medical or dental indications. After examination of the molar and incisor relationship in centric occlusion, the patients were allocated to Angle Class I ($n = 21$) and Angle Class II ($n = 31$) study groups. First the palatal plane was identified as a reference line in the horizontal plane on the monitor of the workstation of the CT assembly (Philips Easy Vision and Tomoscan SR 6000). Acetate papers were fixed to the CT print outs and traced according to Beckmann *et al.* (1998) for lateral headfilms.

RESULTS: The mean angle between the palatal plane and the tooth axis was 109.4 degrees (SD 11.3°) for the central incisor, 112.9 degrees (SD 8.7°) for the lateral incisor, and 101.5 degrees (SD 8.9°) for the canine in the Class I group, and 101.5 degrees (SD 7.5°), 107.7 degrees (SD 9.7°), and 100.8 degrees (SD 8.1°) for the Class II group, respectively.

The mean angle between the axis of the dentoalveolar process and the tooth axis was 13.5 degrees (SD 6°) for the central incisor, 15.2 degrees (SD 7.9°) for the lateral incisor, and 17.5 degrees (SD 5.8°) for the canine in the Class I group, and 17.4 degrees (SD 7.4°), 18.2 degrees (SD 7.8°), and 14.3 degrees (SD 6.2°) for the Class II group, respectively. No statistical differences were found. The mean thickness of the free margin of the alveolar process was as low as 0.8 mm (SD 4.4 mm).

CONCLUSION: A prospective study, including more patients and in addition those with Class II division 2 and Class III malocclusions, will clarify these surprising findings.

Beckman S H, Kuitert R B, Prah-Andersen B, Segner D, The R P S, Tuinzing D 1998 Alveolar and skeletal dimensions associated with overbite. *American Journal of Orthodontics and Dentofacial Orthopedics* 113: 443–452

24 LINGUAL TECHNIQUE—PATIENT CHARACTERISTICS, MOTIVATION AND ACCEPTANCE: INTERPRETATION OF A RETROSPECTIVE SURVEY

U Fritz¹, P Diedrich¹, D Wiechmann², ¹Clinic of Orthodontics, University of Aachen and ²Orthodontic Practice, Bad Essen, Germany

AIM: To collect personal data of patients treated with fixed lingual appliances. Additionally, motivation, acceptance, and treatment impairment were assessed using a questionnaire.

SUBJECTS AND METHODS: Ninety-eight patients (university: 35, practice: 63) participated. The multiple choice questionnaire consisted of 18 items concerning gender, age, profession, type of health insurance, marital status, and parameters such as time of active treatment, first information source, motivation, phonetic-functional impairment, and subjective assessment of the treatment result. The data were analysed statistically using Fisher's exact tests to detect differences between the two groups. The level of significance was set at 5 per cent.

RESULTS: Statistical analysis of the personal data revealed a characteristic type of patient with a preference for lingual treatment: females below 40 years. The mean treatment time was 1–2 years. The lingual treatment was favoured especially for aesthetic reasons. The main impairment (65%) due to the lingual appliance was irritation of the tongue. The phonetic-functional adaptation period was 1–3 weeks. Ninety-five per cent of the patients were content or very content with the treatment result and 87 per cent would recommend the lingual technique unreservedly to family or friends. Fifty-three per cent would have refused orthodontic treatment with ceramic brackets bonded to the labial tooth surfaces.

CONCLUSION: Treatment with a fixed lingual appliance appeals to a characteristic patient group. In general, the level of acceptance among patients was positive and impairments during the adaptation period were tolerated after 1–3 weeks. The lingual technique should be integrated into routine orthodontic practice.

25 MAGNETIC RESONANCE IMAGING FOR MASSETER MUSCLE VOLUME ASSESSMENT IN DISTRACTION OSTEOGENESIS OF THE HUMAN MANDIBLE

D Garbo, T K Pedersen, B Melsen, Department of Orthodontics, Royal Dental College, University of Aarhus, Denmark

AIM: Biomechanical problems related to distraction osteogenesis (DO) and bone reaction have been analysed in animal models and in clinical studies. The changes occurring in the soft tissue envelope have, however, received less attention. Long-term success of DO depends on the ability of the surrounding soft tissues to adapt to the resulting increase in skeletal length and volume. Insufficient predictability of treatment outcome and possible undesired effects on soft tissues demands further research. Among the available imaging techniques, magnetic resonance imaging (MRI) is the most appropriate for *in vivo* soft tissue evaluation. The aim of this research was to establish a method for qualitative and quantitative assessment of the masseter muscle of patients undergoing mandibular DO.

SUBJECTS AND METHOD: To test the method 10 rabbits were scanned in a preliminary study. MRI was then performed on 10 patients with severe unilateral or bilateral underdevelopment of the mandibular ramus. The masseter muscles were traced on the MRI and *in vivo* volume was calculated by software performing three-dimensional reconstruction. In the animal study, the results were compared with the actual weight and volume of the rabbit's masseter. For the patients, in addition to the volume calculation, a qualitative evaluation of the masseter muscle was performed on the two-dimensional images. The error of the method was tested and the data analysed by descriptive statistics, *t*-test, and regression analysis.

RESULTS: A smaller volume was measured on the affected side in asymmetric subjects. Muscle atrophy due to lack of function was evident on the MRIs after DO, although artefacts from residual metal powder degraded the images.

CONCLUSIONS: MRI is confirmed as a valuable tool in assessing muscle morphology and function. Volumetric assessment might be performed with acceptable accuracy. The soft tissue matrix follows the underlying skeletal asymmetry only to a certain extent.

26 EVALUATION OF ORTHODONTIC TREATMENT USING THE PEER ASSESSMENT RATING AND INDEX OF COMPLEXITY, OUTCOME AND NEED INDICES

I Georgiaki, M A Papadopoulos, I Ioannidou, Department of Orthodontics, Aristotle University of Thessaloniki, Greece

AIM: To evaluate treatment outcome in patients with Class II division 1 malocclusions using the Peer Assessment Rating (PAR) and Index of Complexity, Outcome and Need (ICON) occlusal indices, to correlate these two indices, and

to determine which individual factors contribute significantly to treatment outcome.

MATERIAL AND METHOD: Pre- and immediate post-treatment dental casts of 64 patients (mean age: 12.2 ± 1.7 years) with a Class II division 1 malocclusion and overjet ≥ 4 mm, divided into two groups depending on the treatment modality: group I ($n = 42$, headgear and/or functional appliance and fixed appliances); group II ($n = 22$, fixed appliances and premolar extractions). The pre- and post-treatment study models were evaluated using the PAR and ICON indices. Statistical analysis was performed using the statistical software SPSS (level of significance $P \leq 0.05$). For estimating the methodological errors, the whole evaluation was repeated after two weeks on 30 randomly selected cases.

RESULTS: According to the PAR index, great improvement was observed in 84.5 per cent of the total sample, 87.4 per cent of group I, and 80.0 per cent of group II. No significant differences between the two groups concerning the improvement were observed. Alignment of the anterior teeth and overjet were the PAR components with the greatest improvement. According to the ICON, the improvement was 77.5 per cent for the total sample, 76.9 per cent for group I, and 78.6 per cent for group II. No significant difference was observed when comparing the two groups. The correlation between the two indices was positive and highly significant. The treatment outcome was only correlated with the severity of the pre-treatment malocclusion.

CONCLUSIONS: A great improvement of malocclusion was observed and there was no difference in treatment outcome depending on the treatment method, by means of PAR and ICON indices. The single factor that was correlated with treatment outcome was the severity of the pre-treatment malocclusion.

27 THE VALUE OF EXTRA-ORAL PHOTOGRAPHS IN DESCRIBING DENTOFACIAL CHARACTERISTICS

E Gianniou, A E Athanasiou, G Kolokithas, Department of Orthodontics, Aristotle University of Thessaloniki, Greece

AIM: To investigate the value of using only extra-oral photographs to describe dentoalveolar and skeletal characteristics of persons seeking orthodontic treatment.

MATERIALS AND METHOD: Standardized extra-oral profile and frontal view photographs, lateral cephalometric radiographs, and study casts of 67 patients seeking orthodontic treatment. Twenty-five specialists in orthodontics of various ages, educational background, and clinical experience evaluated the photographs by direct observation only. They were asked to complete a 24-question form and provide descriptions regarding three-dimensional dentoalveolar and skeletal relationships and characteristics. The information collected was then compared with corresponding data gathered by elaboration of lateral cephalometric radiographs and study casts by the first author. In order to examine the correlation between the subjective answers of

the judges and the objective results (lateral cephalometric radiographs and study casts), Pearson's Chi-square and Spearman's r -tests were used for statistical analysis.

RESULTS: (1) Recognition of the main sagittal dentoalveolar and skeletal relationships using profile photographs is sufficiently feasible; (2) frontal view photographs cannot adequately contribute to the recognition of most of the sagittal characteristics; (3) information provided by photographs concerning vertical relationships, with the exception of overbite and parameters related to the lower third of the face, is limited; (4) it was not possible to recognize sagittal and vertical dentoalveolar and dental relationships.

CONCLUSIONS: Several sagittal and few vertical dentoalveolar and facial skeletal relationships may be recognized by assessing only extra-oral photographs.

28 A PROSPECTIVE STUDY COMPARING THE DENTO-SKELETAL EFFECTS OF TWO FUNCTIONAL APPLIANCES

D Gill, A. Sharma, R Lee, The Royal London Hospital, England

AIM: To compare the dento-skeletal effects of the Twin block (TB) appliance with a modified form of this appliance termed the Mini block (MB).

SUBJECTS AND METHODS: The treatment groups were age and sex matched and a total of 60 of the original 70 patients, who fulfilled specific inclusion criteria, completed this trial (TB: $n = 30$; MB: $n = 30$). The TB appliance was constructed with a large single step advancement. The modifications incorporated into the MB appliance included progressive mandibular advancement bite blocks of reduced vertical dimension and a maxillary incisor torquing spring. Active treatment with each appliance lasted nine months irrespective of the final overjet attained. The MB appliance was advanced by 2 mm increments after three and six months wear. A lateral cephalograph was taken within one month of starting treatment and three months after appliance withdrawal in order to minimize mandibular posturing for the final cephalometric record.

RESULTS: Both groups showed pre-treatment equivalence for age, sex, overjet, and cephalometric variables. The TB group experienced a significantly greater reduction in overjet (median = -8 mm; $P = 0.02$) compared with the MB group (median = -4 mm). This improved overjet reduction was associated with significantly greater forward movement of pogonion relative to sella-vertical (median change: TB = 3.3 mm, MB = 2.1 mm; $P = 0.02$) and significantly greater retroclination of the maxillary incisors (median change: TB = -5° ; MB = -1.9° ; $P = 0.04$). There was no significant difference between groups in the change in total anterior facial height (median change: TB = 4.4 mm, MB = 4.3 mm) and lower incisor proclination (median change TB = 1.3° , MB = 2.4°).

CONCLUSIONS: Progressive mandibular advancement with the MB appliance was not associated with more mandibular growth compared with single step advancement with the TB

appliance. The maxillary incisor torquing spring appears to be effective at reducing maxillary incisor retroclination.

29 ORTHODONTICS: NEW APPROACHES TO OLD PROBLEMS

L Graber

KEYNOTE ADDRESS

This presentation will focus on the impact of new technologies on the clinical practice of orthodontics. Two separate aspects will be discussed to highlight the changing environment within which orthodontics is practiced. Firstly, there will be a review of the impact of computer technology on patient communication and how this has altered the doctor/patient relationship. How are the new communication 'technologies' influencing the delivery of healthcare information? Secondly, a review of the impact of new orthodontic appliance systems will be made. The Invisalign orthodontic treatment system will be reviewed as an example of an innovative mode of treatment based on integration of new treatment technologies with changing patient expectations. Concerns for patient selection, treatment planning, and management will be discussed.

In today's orthodontic treatment world, 'new' may no longer be assumed to always equate to 'better', but it surely is different!

30 THREE-DIMENSIONAL SOFT-TISSUE CHANGES FOLLOWING ORTHOGNATHIC SURGERY

M Y Hajeer, D T Millett, University of Glasgow Dental School, Scotland

AIMS: (1) To assess facial soft tissue changes following orthognathic surgery using a three-dimensional (3D) landmark-based analysis and (2) to assess the magnitude of relapse in the post-surgical period.

SUBJECTS AND METHODS: Thirty-nine Caucasian patients (13 Skeletal II, 26 Skeletal III) who required orthognathic surgery to correct their dentofacial deformities. 3D facial images were obtained at: (T1) one week before surgery, (T2) three months post-surgery, and (T3) six months post-surgery. The images were taken in centric occlusion with the patient's head in the natural head position and the lips in repose. 3D models were constructed and exported to the Facial Analysis Tool™ in which 30 landmarks were identified and the *x*-, *y*-, *z*-co-ordinates were obtained. Superimposition between any two models was carried out by aligning the co-ordinate systems, via translation and rotation, employing Partial Procrustes Analysis using seven stable landmarks.

RESULTS: For surgical changes, displacements of landmarks in the *x*-axis were very slight, statistically insignificant and, as expected, most affected the *z*- (antero-posterior) and *y*- (vertical) co-ordinates. Mean *z*-displacement of pogonion in the Class II and III subgroups was +9.3 and -4.5 mm, respectively. The overall changes (T1-T3) of superior labial

sulcus, inferior labial sulcus, and pogonion were statistically significant ($P < 0.01$) for both subgroups, while displacements of these points from T2 to T3 were statistically insignificant. **CONCLUSIONS:** (1) Landmark-based analysis is a valuable tool for studying facial changes; (2) a statistically insignificant relapse occurred between 3 and 6 months post-surgery.

31 LONG-TERM FOLLOW-UP AFTER CLASS II CORRECTION—A COMPARATIVE STUDY

K Hansen¹, B Nelson², U Hägg³, Departments of Orthodontics, Universities of ¹Gothenburg and ²Malmö, Sweden and ³Hong Kong

AIM: To compare long-term the skeletal and dental effects of Class II elastics with the changes obtained by the Herbst telescope mechanism.

SUBJECTS AND METHOD: Thirty male Class II division 1 subjects were analysed. Fifteen subjects were treated with fixed appliances (*ad modum* Begg) and Class II elastics and 15 with the Herbst appliance. Lateral radiographs in centric occlusion were analysed at the start of treatment, after treatment and follow-up, and at least five years after the end of treatment. **RESULTS:** The sagittal skeletal improvement of the jaw base relationship was significantly larger ($P < 0.01$) in the Herbst than in the Begg sample during the treatment period. The continued jaw growth after treatment was on average significantly larger in the Begg than in the Herbst sample ($P < 0.05$). The jaw base relationship continued to improve in both groups after treatment, and at the end of the follow-up period (5-9 years after treatment) there was no significant difference between the two groups. The individual variation was, however, large and unpredictable after treatment. In the vertical perspective the mandibular plane angle increased significantly during treatment in the Begg group ($P < 0.01$) but remained unchanged in the Herbst group. During the follow-up period the mandible rotated anteriorly in both groups ($P < 0.01$). Due to a large individual variation there was no statistical difference between the groups regarding the size of the mandibular plane angle at any stage.

CONCLUSIONS: The sagittal skeletal effect of the Herbst appliance is larger than that of Class II elastics during treatment. However, the individual, unpredictable growth pattern after treatment erased these differences on a long-term basis. The mandibular plane angle increased in the Begg sample during treatment but was later normalized.

32 ORAL HYGIENE BENEFITS OF INTERDENTAL CLEANING IN LINGUAL ORTHODONTIC PATIENTS

A Hohoff, N Kuehne, T Stamm, Department of Orthodontics, University of Münster, Germany

AIM: To determine the benefit of the WaterPik Flosser (Intersanté) for oral hygiene in lingual orthodontic patients.

SUBJECTS AND METHOD: Forty-eight patients with lingual brackets in at least one arch [34 females, 14 males,

mean age 26.2 years (SD 8.5), range 12.5–48.7 years]. Approximal plaque index (API) and sulcus bleeding index (SBI) were examined according to the method of Silness and Løe and Muehleman and Son, respectively. Within a maximum time period of 5.5 months these indices were checked by an orthodontist at the lingual surfaces three times: before application of the WaterPik Flosser (c), at the first appointment after the application of the WaterPik Flosser (a1), and at the second appointment after the application of the WaterPik Flosser (a2). The WaterPik Flosser was used once a day by the patients only in the second and forth quadrants (WP quadrants) following a single preceding instruction by the orthodontist. In the WP quadrants as in the non-WaterPik (nWP) quadrants, oral hygiene was undertaken with a toothbrush. Statistical analysis was performed using SPSS 10.0. Values of $P \leq 0.05$ in the Wilcoxon test were considered to be significant.

RESULTS: Total API reduced significantly from a mean value of 46.4 per cent (SD 28.0) at c to 20.3 per cent (SD 18.1) at a1 and to 10.3 per cent (SD 8.7) at a2. The total SBI significantly reduced from a mean value of 14.8 per cent (SD 14.4) at c to 4.9 per cent (SD 9.0) at a1 and to 2.1 per cent (SD 4.6) at a2. At a1 and a2 the API in the WP quadrants differed significantly from the nWP quadrants: a1 12.5 per cent (SD 13.3) in the WP quadrants versus 21.0 per cent (SD 14.1) in the nWP quadrants; a2 5.1 per cent (SD 7.1) in the WP quadrants versus 13.5 per cent (SD 12.6) in the nWP quadrants.

CONCLUSIONS: The WaterPik Flosser is a useful tool to improve oral hygiene in lingual orthodontic patients.

33 COMPUTER MODELLING IN ORTHODONTIC BIOMECHANICS: THE IMPACT ON CLINICAL PRACTICE

M Jones, J Knox, J Hickman, Dental School, University of Wales College of Medicine, Cardiff, Wales

KEYNOTE ADDRESS

INTRODUCTION: An approach to modelling biomechanical problems in orthodontics is presented. The background to finite element based solution systems is described based on 10 years work in this area. Included is an introduction to the study of interface behaviour of orthodontic materials. Details of specific studies in tooth movement will be presented as an illustration of the flexibility of the method.

AIM: A variety of methods, including physical and holographic models, have been used to gain a greater insight into tooth response to loading. Knowledge of how teeth move following the placement of a force is fundamental to our understanding of orthodontic treatment. It is important information to have when one designs new methods and systems for treatment. Over the last decade various computer models have been applied to study the problem. One useful approach is to use the Finite Element Method (FEM) to study the biomechanics of tooth movement. The

aim of this study was to develop a three-dimensional computer model of the movement of a maxillary incisor tooth when subjected to an orthodontic load. A new method employing a laser apparatus was used to measure movement of incisor teeth in human volunteers, this was to be used to validate the FEM model.

METHOD: The laser apparatus sampled tooth movement every 0.01 seconds over a 1-minute cycle whilst a 0.39 Newton load was applied. This approach to recording time-dependent tooth movement was repeated on eight separate occasions for 10 subjects. The most consistent five readings were used to calculate the physical properties of the periodontal ligament (PDL) and provide data to develop the computer model.

RESULTS: Tooth displacements ranged from 0.012 to 0.133 mm. An appropriate elastic modulus of 1 Nmm² and Poisson's ratio of 0.45 were derived for the PDL. A 15 000 four-noded tetrahedral element model was constructed which gave a graphic simulation of the tooth movement and the time-dependent strains in the PDL and the surrounding modelled alveolar bone. The maximum strains recorded for the surrounding alveolar bone were 35 times less than for the PDL.

DISCUSSION: A novel method for direct measurement of PDL properties and time-dependent tooth movement in humans is presented. The data were used to validate a computer-generated time-dependent FEM model. This lends further evidence that the PDL is the main mediator of tooth movement.

34 MASSETER MUSCLE THICKNESS AND MAXILLARY DENTAL ARCH WIDTH

C Katsaros, I Georgiakaki, S Kiliaridis, Department of Orthodontics and Oral Biology, University of Nijmegen, The Netherlands and Department of Orthodontics, University of Geneva, Switzerland

AIM: To study the relationship between the ultrasonographic thickness of the masseter muscle and the width of the maxillary dental arch.

SUBJECTS AND METHOD: Sixty consecutive orthodontic patients (37 females, 23 males), 7–18 years of age with a Class I relationship and a minor malocclusion. The thickness of the masseter muscle was measured ultrasonographically. Recordings were performed bilaterally with the muscles both relaxed and contracted. The maxillary intermolar width was measured with an electronic calliper as the distance between the palatal surfaces of the first permanent molars.

RESULTS: Intermolar width showed no association with age and gender. However, masseter muscle thickness showed a direct, significant association with these two factors together, i.e. the masseter muscle was thicker in older individuals and in males. In the female group, maxillary intermolar width showed a direct, significant association with masseter thickness both during contraction and

relaxation, i.e. females with thicker masseter muscles had a wider maxillary dental arch. In the male group, however, no significant relationship was found between maxillary intermolar width and masseter thickness.

CONCLUSIONS: The functional capacity of the masticatory muscles may be considered as one of the factors influencing the width of the maxillary dental arch.

35 JUDGEMENT OF FACIAL AESTHETICS BY ADULT LAYMEN AND ORTHODONTISTS

R M A Kiekens, J C Maltha, M A van 't Hof, Department of Orthodontics and Oral Biology, University of Nijmegen, The Netherlands

AIM: To determine the opinion of laymen and professionals on facial aesthetics in orthodontic patients.

MATERIAL AND METHOD: Pre-treatment photographic views (frontal, 3/4 smiling, and lateral) of 64 healthy Caucasian orthodontic patients, aged 10–16 years, were selected at random with stratification for gender and Angle classification. A panel of 78 adult laymen (38 males, 40 females) and a panel of 89 orthodontists (38 males, 51 females) were constructed. The panels rated the photographic views using a visual analogue scale (VAS), from 0 to 100, in relation to a previous selected reference photographic view (one boy, one girl). Duplicate photographic views of 10 per cent of the patients were added to the series.

RESULTS: The reliability of the measurements for both panels was good (Cronbach's $\alpha = 0.98$). The median individual random error was 6.8 ($P_{25} = 4.7$; $P_{75} = 10.5$) for the laymen and 10.6 ($P_{25} = 6.4$; $P_{75} = 19.8$) for the orthodontists. The median individual reliability was 0.68 ($P_{25} = 0.44$; $P_{75} = 0.81$) for the laymen and 0.65 ($P_{25} = 0.48$; $P_{75} = 0.84$) for the orthodontists. The Pearson correlation between the orthodontists and laymen was 0.92. The orthodontists were more critical than the laymen, with female orthodontists being more critical than male orthodontists. Such a gender difference was not found for the lay judges. In both panels, there was a significant difference in aesthetic scores with Class III patients being the least attractive, and Class II division 2 being the most attractive. There was a significant negative correlation between the aesthetic component of the Index of Orthodontic Treatment Need and the VAS values.

CONCLUSION: Judgement of facial aesthetics by laymen and orthodontists is reliable. Orthodontists are more critical in judging facial aesthetics than laymen.

36 UNOPPOSED MOLARS IN ADULTS: FACTS AND FICTION

S Kiliaridis, Department of Orthodontics and Pedodontics, University of Geneva, Switzerland

KEYNOTE ADDRESS

The purpose of this presentation is to elucidate the 'behaviour' of molars without antagonists, with respect to the risk of over-eruption in adults. In a recent study it was

found that the great majority of dentists believed that in adults, marked over-eruption of molars occurs without antagonists. Furthermore, approximately 50 per cent of the dentists feared that this serious over-eruption occurs in the short-term, and therefore they proposed immediate treatment to avoid this complication. However, what is the evidence that supports these opinions?

In a clinical retrospective study 53 individuals who had 84 molars without antagonists for a documented period of 10–27 years were studied and the position of these molars on the dental casts in relation to the occlusal plane were evaluated. It was found that 24 per cent of these teeth showed moderate to severe supraposition (>2 mm), 18 per cent revealed no signs of supraposition, and 58 per cent displayed a mild supraposition (from 'just detectable' to <2 mm). It seems that the mature adult individuals who lose an antagonist tooth face less risk of over-eruption of their unopposed molars than younger subjects. A longitudinal study is in progress to monitor the direction and the amount of over-eruption of unopposed molars in adult individuals during a 10-year period.

Besides the fact that extensive over-eruption is not the common 'behaviour' for unopposed molars in adults, there are still numerous cases that should be considered as a treatment challenge for the clinician.

37 PSYCHOLOGICAL ASSESSMENT OF ORTHOGNATHIC PATIENTS

J Kindelan¹, A Bedford², Department of ¹Orthodontics and ²Clinical Psychology, York Health Services NHS Trust, England

AIMS: To measure the levels of anxiety, depression, extroversion, neuroticism, hostility, and diffidence in a group of potential orthognathic patients.

SUBJECTS AND METHODS: Sixty-one consecutive new patients attending the combined orthognathic clinic (57 per cent female, 43 per cent male). All patients were attending their first joint orthognathic appointment, and were asked to complete a short battery of three self-report questionnaires.

RESULTS: The Personal Disturbance Scale (DSSI/sAD) provides a measure of recently experienced anxiety and depression. Females were more likely to be symptom-free and both sexes had approximately 10 per cent of individuals scoring highly, compared with general population normative data. All male high scorers were 15–18 years of age. The Eysenck Personality Questionnaire-Revised scored 63 per cent of subjects highly for extroversion and this could be a reflection of their motivation to seek treatment for their malocclusions. With regard to neuroticism, the subjects displayed no gender difference and scored low compared with the general population. The Personality Deviance Scales-Revised displayed an excess of cases scoring low on diffidence, i.e. they characterized themselves as being self-confident and socially dominant.

CONCLUSIONS: These orthognathic patients tend towards being young, female, emotionally stable extroverts. They

are self-confident, socially dominant, and normal in their hostility levels. Psychological questionnaires may be particularly useful in assessing borderline subjects for orthognathic surgery, and in highlighting those where further psychological assessment or therapy is required.

38 ROBIN SEQUENCE: CRANIOFACIAL MORPHOLOGY AND GROWTH STUDIED BY THREE PROJECTION CEPHALOMETRY

S Kreiborg, N V Hermann, B L Jensen, Faculty of Health Sciences, University of Copenhagen, Denmark

AIM: To analyse craniofacial morphology and growth in children with untreated non-syndromic Robin Sequence (RS) and to compare the findings with those in a control group.

SUBJECTS AND METHOD: The subjects were drawn from a group of children representing all Danish cleft children born between 1976 and 1981. The RS group comprised seven children, and the control group 45 children with an incomplete cleft lip. All children were examined at both 2 and 22 months of age. The investigation was undertaken using cephalometry in three projections. Craniofacial morphology was analysed using linear, angular, and area variables. Growth at a specific anatomical location was defined as the displacement vector of the landmark from examination 1 to examination 2, corrected for radiographic magnification. Statistical testing of differences between means was carried out using *t*-tests.

RESULTS: The most striking findings in the RS group were: an increased maxillary width and nasal cavity; a short maxilla with reduced posterior height; a short mandible; bimaxillary retrognathia; and severe reduction of the pharyngeal airway, especially at the oropharyngeal level. The amount of facial growth from 2 to 22 months of age was similar in the two groups; however a more vertical growth direction was observed in the RS group.

CONCLUSION: Infants with RS are characterized not only by mandibular but also by maxillary retrognathia. Reduction in the size of the pharyngeal airway is most pronounced at the oropharyngeal level. There is no sign of mandibular catch-up growth in RS children. The magnitude of facial growth is normal, but the growth direction is more vertical than normal in the RS group.

39 RESPIRATORY FUNCTION DOES NOT INCREASE STEADILY DURING GROWTH

M T Laine-Alava, D W Warren, University of Oulu, Finland and University of North Carolina at Chapel Hill, USA

AIM: Partial oral breathing due to impaired nasal breathing affects dentofacial growth in some individuals. In assessing upper airway obstruction, clinical observation alone is not sufficient and actual measurements of rest breathing and guideline values for these measurements, based on a healthy

population, are necessary. In this study, it was hypothesized that upper airway respiratory needs increase steadily during growth and show sexual dimorphism.

SUBJECTS AND METHOD: Two age cohorts ($n = 115$) in Vimpeli, a rural area in Western Finland, were examined annually from 8 to 17 years of age. The pressure-flow technique (Warren *et al.*, 1984) was used to measure upper airway airflow rate (ml/s).

RESULTS: Airflow rate increased during the nine-year period from a median of 339 to 493 ml/s in girls and from 406 to 563 ml/s in boys. The values were systematically larger for boys and the gender difference was statistically significant ($P < 0.05$, Mann-Whitney test) but only for the youngest and oldest age groups. Instead of increasing steadily, there was a decrease in airflow rate from 10 to 11 and again from 13 to 14 years of age in girls, and a year later in boys. Wilcoxon test showed the increase between those periods to be statistically significant in both sexes.

CONCLUSIONS: Age- and gender-specific guideline values are needed to assess respiratory pattern, critically important for diagnosis and treatment planning in individuals with cleft-palate, craniofacial anomalies, sleep apnoea, developing skeletal malocclusions, or pre- or post-orthognathic surgery.

40 NEOVASCULARIZATION AND BONE FORMATION IN THE CONDYLE DURING STEPWISE MANDIBULAR ADVANCEMENT

F Y C Leung, A B M Rabie, U Hägg, Orthodontics, University of Hong Kong, China

AIM: To identify the temporal expression of vascular endothelial growth factor (VEGF) in the mandibular condyle and to correlate it with the pattern of new bone formation during stepwise mandibular advancement.

MATERIALS AND METHODS: Two hundred and fifty female, 35-day-old Sprague Dawley rats were randomly divided into 10 groups, with 10 rats allocated to the single-step bite-jumping subgroup, 10 rats to the stepwise advancement subgroup, and five rats to the control subgroup. In the experimental groups, the mandibles were kept in a continuous forward position. The initial stepwise advancement started on day 35, while the second advancement started on day 65. The rats were sacrificed on experimental days 3, 7, 14, 21, 30, 33, 37, 44, 51, and 60. Sections were cut through the condyle at the parasagittal plane and stained with anti-VEGF antibody. Each was counter-stained with haematoxylin for observation of the cellular response. Sections were digitized and quantitatively analysed with a computer-assisted image analysing system.

RESULTS: The initial advancement in the stepwise group resulted in significantly less expression of VEGF when compared with single advancement. However, the second advancement on day 30 resulted in a significant increase in VEGF expression when compared with both the one step group and the natural growth control group.

CONCLUSIONS: Changes in the amplitude of mechanical loading produced by stepwise advancement have a significant

effect on the production of VEGF by the chondrocytes. The later stages of the advancement produced more VEGF and more bone in the condyle.

41 THE LIMIT OF THE DENTITION

F Magni, School of Orthodontics, University of Cagliari, Italy

KEYNOTE ADDRESS

The concept of the anterior limits of the dentition in relation to aesthetics, stability, and function has changed throughout the years. In the 1960s the emphasis was on stability, and the need for permanent retention of the anterior teeth was considered a treatment failure. The postural tone of the soft tissues surrounding the dentoalveolar complex determined the stable limits of the dentition. Later, the tendency was to promote both the correct occlusal and temporomandibular joint functions. Post-treatment occlusal equilibration and permanent retention of the anterior teeth became acceptable. Recently, aesthetics has become the predominant factor. In most treated cases, permanent retention in the lower and often in the upper arch is necessary in order to maintain the obtained aesthetic position. We are witnessing an increase of studies focusing on the improvement of the patient's smile, in determining the best occlusal plane in relation to the lip embrasure and the best arch form; at the same time sound research studies on the influence of the soft tissue environment on the dentoalveolar tissue have decreased. Nowadays, moving teeth within the alveolar tissue, and correcting severe skeletal discrepancies, with the help of maxillofacial surgery is no longer an issue. However, when the problem is the anatomical discrepancy of the soft tissues in relation to the underlying basal bones, we have to make therapeutic compromises. The characteristics of the soft tissue that may determine the natural limits of the dentition will be illustrated. These characteristics include the role of the perioral musculature, the lower lip tone and height, the level of the retentive line and the anterior oral seal, as well as the vertical skeletal morphology, the height of the maxillary anterior dentoalveolar complex and of the upper incisor crowns. Subsequently, the cephalometric soft tissue discrepancy analysis and the quadrilateral visual treatment objective are demonstrated as effective methods in determining: (1) the amount of soft tissue disproportion; (2) the need for permanent retention; (3) the type of permanent retention; and (4) the option for a more drastic solution such as a surgical elongation of the soft tissues or a surgical reduction of the basal bone.

42 DENTOSKELETAL EFFECTS OF MANDIBULAR WIDENING USING DISTRACTION OSTEOGENESIS

S Malkoç, H İşeri, N Mutlu, Departments of Orthodontics and Oral and Maxillofacial Surgery, Universities of Selçuk and Ankara, Turkey

AIM: To evaluate the effects of mandibular symphyseal distraction osteogenesis (MSDO) on the dentoskeletal structures and mandibular condyle.

SUBJECTS AND METHODS: Ten patients (two males, eight females) with an age range between 15.4 and 25.8 years at the time of the surgery. All patients required MSDO, based primarily on mandibular dental crowding. A custom-made, intra-oral rigid bone and tooth-borne distraction device was inserted after surgery and activated twice a day, once in the morning and once in the evening, a total amount of 1 mm per day. Records, including postero-anterior (PA) and submentovertex (SMV) cephalograms and study casts, were obtained before surgery, and at the end of the distraction and retention periods (90 days after surgery). The data were analysed statistically using paired *t*-tests.

RESULTS: The mean anterior mandibular widening was 7 mm ($P < 0.001$) with a range of 6.5–10 mm. A distraction gap was observed in the symphyseal region at the end of the distraction procedure. Significant widening was also noted in the dentoalveolar region, but the widening effect gradually decreased from the mandibular canines (mean 7 mm, $P < 0.001$) to the second molars (mean 1 mm, $P < 0.05$). No significant skeletal changes were observed in the bigonion width on the PA films. Therefore, the mandible was found to separate in a non-parallel manner (wedge-shape), antero-posteriorly and supero-inferiorly. Post-distraction SMV cephalometric analysis demonstrated that intercondylar angle was increased and the distance between the condyles was significantly decreased ($P < 0.001$), while no significant changes were observed during the retention period.

CONCLUSION: MSDO provides an efficient non-extraction treatment approach by increasing the anterior mandibular base and dental arch widths, and would be an alternative in the treatment of mandibular crowding, especially in borderline cases.

43 INFLUENCE OF RETENTION ON RELAPSE IS DEPENDENT ON THE AMOUNT OF ACTIVE ORTHODONTIC TOOTH MOVEMENT

J M C Maltha, E J van Leeuwen, Department of Orthodontics and Oral Biology, University of Nijmegen, The Netherlands

AIM: To describe the process of relapse after tooth movement in beagle dogs with different force regimes and with or without retention.

MATERIAL AND METHODS: Nineteen young adult beagle dogs. Three months after extraction of the mandibular third premolars, an orthodontic appliance was placed. Standardized forces of 10 and 25 cN were used to bodily distalize the second premolar. The forces were applied continuously (24 h/day) or discontinuously (16 h/day). Active tooth movement was performed for four months. In half of the animals relapse was allowed immediately after active movement, while in the other animals relapse was preceded by retention for 90 days. Time-displacement curves were constructed and used for statistical analyses of the

relationship between force magnitude, force regime, and retention on the one hand, and relapse characteristics such as duration and total amount of relapse on the other.

RESULTS: Force magnitude had no effect on relapse, while continuous forces resulted in a longer lasting ($P = 0.03$) and more pronounced ($P = 0.04$) relapse than discontinuous forces. Retention had no effect on the duration of the relapse period ($P = 0.88$), but it strongly decreased the total amount of relapse ($P < 0.01$). A significant positive correlation was found between the amount of active tooth movement and the rate ($r = 0.51$, $P < 0.001$) and the total amount ($r = 0.60$, $P < 0.001$) of the relapse, but not between the active movement and the duration of the relapse ($r = 0.21$, $P = 0.21$). Finally, the effect of retention on the amount of relapse was strongly correlated to the amount of initial displacement ($r = 0.86$, $P < 0.001$).

CONCLUSIONS: (1) The duration of relapse is independent of the force magnitude or the amount of tooth displacement during active treatment; neither is it influenced by retention. (2) The decreasing effect of retention on the amount of relapse is more pronounced if a tooth has been moved over a longer distance.

44 THE PREVALENCE OF AGENETIC PERMANENT TEETH IN THE CAUCASIAN POPULATION DURING THE 20TH CENTURY. A META-ANALYSIS

N Mattheeuws, L Dermaut, G Martens, Department of Orthodontics, University of Gent, Belgium

AIM: It has been generally claimed that agenesis of permanent teeth has increased over the years. The present study intended to confirm this hypothesis in Caucasians for the past 65 years.

MATERIAL AND METHODS: Published data on the prevalence of children with one or more congenitally missing permanent teeth were selected based upon a series of strictly imposed criteria. Using meta-analysis the data were evaluated and presented chronologically. Possible trends over the years were expressed as a best fitting line in the diagram. Furthermore the selected publications were checked to determine differences in the prevalence of agenesis between males and females. Initially, information on the occurrence of upper and lower premolars as well as upper and lower incisors was collected and calculated as a percentage of the total number of congenitally missing teeth for each of the studies considered.

RESULTS: From more than 40 studies 20 were selected based upon seven criteria. Chronological classification of the percentage of children with congenital absence of one or more permanent teeth revealed a slightly increasing trend over a period of 58 years. Fourteen out of the 20 studies presented data on sex distribution. In all but one publication it was reported that girls tended to have a slightly higher occurrence of missing teeth compared with boys of the same age. The second lower premolars were most often agenetic, whereas missing upper lateral incisors

occurred almost equally as agenesis of the upper second premolars.

CONCLUSIONS: Even though the considered period of time is undoubtedly short to investigate a possible trend for hypodontia, this meta-analysis seems to confirm that there is an increasing number of agenetic permanent teeth in the human dentition.

45 EFFECTS OF EARLY CERVICAL HEADGEAR TREATMENT ON DENTAL ARCHES—A RANDOMIZED LONGITUDINAL STUDY

R Mäntysaari, P Pirttiniemi, T Kantomaa, Institute of Dentistry, University of Oulu, Finland

AIM: To determine the effects of early headgear treatment on dental arches in children in the early mixed dentition. The hypothesis was that with early use of cervical headgear significant increases in dental arch dimensions could be gained.

SUBJECTS AND METHODS: Sixty-eight children of both sexes aged 7.6 years (SD 0.3 years). The children who had a Class II tendency in occlusion and moderate crowding of the dental arches were randomly divided into two groups of equal size, matched according to gender. In the first group headgear treatment was initiated immediately. The mean treatment time in the headgear group (HG) was 16 months. In the second group, which served as the control, only minor interceptive procedures were performed during the follow-up period. The records, which included dental casts and lateral cephalograms, were taken after one- and two-year follow-up periods.

RESULTS: The length and width of the maxillary dental arch were significantly increased in the HG group after the two-year follow-up period. The length and the width of the lower dental arch were also significantly increased in the HG group. The mean increase in the length of the lower arch was 2.4 mm (SD 1.7 mm) and in the width 2.2 mm (SD 1.2 mm). On average the space gain in the lower arch was half of that found in the upper arch. No significant changes were found in the arch dimension of the control group.

CONCLUSIONS: The use of headgear in the early mixed dentition is effective in the treatment of moderate crowding. It is noteworthy that significant space gain in the dimensions of the lower arch can be achieved by headgear attached to the upper first molars.

46 THE CHOICE BETWEEN ORTHODONTICS AND SURGERY IN BORDERLINE CASES—CLINICAL INSIGHTS

R P McLaughlin, San Diego, California, USA

Many studies have reported norms and ideal perspectives on orthodontic treatment. However, the limits of non-surgical orthodontic treatment are very unclear. This is due to the

many variables involved in establishing these limits. Such variables include differences in growth patterns, abilities of the orthodontists, degree of patient co-operation, cultural and personal perspectives on what is an acceptable result, etc. While definitive research in this area is not available, clinical insights into the limits of treatment may set the stage for future research. It is helpful to discuss this subject relative to the vertical, horizontal, and transverse dimensions.

Vertical: Misconceptions exist concerning the ability to open and close the mandibular plane with and without the extraction of teeth. Changes that do occur are primarily due to growth variations, and only very minimal changes can be made orthodontically. Therefore the focus in the vertical dimension should be placed on the dentoalveolar changes that can be achieved in the anterior and posterior segments.

Horizontal: The limits of treatment in Class II and Class III cases can be focused on the antero-posterior relationship of the maxilla to the mandible (for example, by looking at such measurements as the Wits measurement) and on the torque or inclination of the upper and lower incisors.

Transverse: Unrealistic expansion of the lower arch is one of the major problems in orthodontics, despite the extensive literature indicating that such expansion is unstable in the majority of cases. Management of the transverse dimension should be based on a realistic evaluation of where the mandibular teeth should be positioned.

47 BONE REACTION TO IMMEDIATE LOADING OF ORTHODONTIC IMPLANTS

B Melsen, M Dalstra, P M Cattaneo, Department of Orthodontics, Royal Dental College, University of Aarhus, Denmark

AIM: To evaluate the deformation by means of a finite element (FE) analysis of the surrounding bone generated when an orthodontic implant is loaded and to relate these findings to the biological reaction observed histologically in a monkey experiment.

MATERIAL AND METHODS: A three-dimensional FE-model was generated of an orthodontic anchorage screw, 7 mm long and 2.1 mm in diameter, and the surrounding bone. The screw was loaded with 50 cN pulling perpendicular to the long axis through the head of the screw. Eight different scenarios were simulated in which the cortical bone had a thickness of 0.5, 1.0, 1.5, or 2 mm, while the underlying trabecular bone was assumed to be either dense or porous. The deformation patterns and the stress distributions in the cortical and trabecular bone were determined. In a monkey experiment 16 screws were inserted: eight into the retromolar area of the mandible and eight into the infrazygomatic crest. They were all loaded immediately. After 1–3 months the bone reaction adjacent to the screws was evaluated histomorphometrically.

RESULTS: The largest deformations and stresses were found in the model with the thinnest cortex and the underlying porous trabecular bone. The accompanying

strain was a result of an interaction between the added load and the deformation occurring during chewing due to the difference in stiffness of bone and screw. Histological examination revealed that after 1 month the bone-to-screw contact was more than 30 per cent and after 3 months the density of the trabecular bone was significantly increased.

CONCLUSION: Immediate loading in combination with forces generated during function will result in a mild overload and thus bone formation adjacent to the orthodontic anchorage screw.

48 ARCH DISCREPANCY MEASUREMENT: COMPARISON OF VISUAL, MANUAL, AND COMPUTER-AIDED METHODS

L Mergati, M F Sfondrini, V Cacciafesta, Department of Orthodontics, University of Pavia, Italy

AIM: To compare five different methods for measuring arch discrepancy.

MATERIALS AND METHODS: The mandibular plaster casts of 44 patients (17 males, 27 females in the permanent dentition, aged 15–25 years) were evaluated by means of five different methods. The Nance method consisted of measuring, with a brass wire, the length of the mandibular arch, whereas the sum of the mesio-distal diameter of the permanent teeth (premolars, canines, and incisors) was calculated with a gauge. The amount of dentoalveolar discrepancy was the difference between the two values. According to the Hunter method, the lower arch was divided into four segments, from the mesial aspect of the first molars to the mesial aspect of the canines, as well as from the mesial aspect of the canines to the mesial aspect of the central incisors for each side. These segments were measured with a calliper. The same device was used to measure all teeth mesial to the first molars. The difference in the measurements represented the dentoalveolar discrepancy. The May method consisted of measuring each tooth mesial to the first molars and the space available for each one in the arch. For the visual method, two dental students and two experienced orthodontists evaluated 'at a glance' the amount of discrepancy. Finally, the computer-aided method consisted of calculating the mesio-distal diameters and the space available in the arch by means of a digitizer connected to computer software (Quick Ceph Image). Statistical analysis (ANOVA) was performed.

RESULTS: No statistically significant differences in mean dentoalveolar discrepancy ($P > 0.05$) were found among all the methods tested for measuring arch discrepancy.

CONCLUSIONS: Clinical reliability of all the methods employed for arch discrepancy measurement is similar. Therefore, the visual method can be considered a valid alternative to more sophisticated methods.

49 A CRITICAL VIEW OF TREATMENT PRIORITY INDICES IN ORTHODONTICS

B Mohlin¹, J Kuroi², ¹Göteborg University and ²Malmö University, Sweden

AIM: To analyse whether orthodontic treatment priority indices used to select patients for treatment are sufficiently sensitive to select in the middle of the range of treatment need and whether these selections are in agreement with a professional opinion.

SUBJECTS AND METHOD: Two series of four patients each were selected to represent moderate and severe levels of treatment need. Forty orthodontists judged the study casts, photographs, dental pantomograms, and cephalograms, and were asked to grade according to the Swedish Medical Board index, the Indication Index, the Index of Orthodontic Treatment Need (IOTN) Dental Health Component, and the IOTN Aesthetic Component, and to calculate weighted and unweighted Peer Assessment Rating score.

RESULTS AND DISCUSSION: The four indices used by the 40 orthodontists offered only little help in the selection of patients and cannot serve as main cut-off points for treatment need.

50 MALOCCLUSION AND TEMPOROMANDIBULAR DYSFUNCTION—A COMPARISON OF SUBJECTS WITH NO OR SEVERE DYSFUNCTION

B Mohlin, K Derweduwen, R Pilley, Universities of Göteborg, Sweden and Manchester and Surrey, England

AIM: To study the influence of malocclusion, characteristics of occlusion, and articulatory movements as well as psychological factors and muscular endurance when comparing subjects with no recorded signs and symptoms of temporomandibular dysfunction (TMD) at the age of 11, 15, and 19 years with those with the most severe dysfunction at 19 years of age.

SUBJECTS AND METHOD: Initially 1000 subjects were examined at the ages of 11, 15, and 19 years in a study of factors motivating for orthodontic treatment. Anamnestic and clinical recording of TMD as well as clinical recording of mandibular movements was carried out. Morphology, including calculation of Peer Assessment Rating (PAR) scores was recorded on study models. A previous history of orthodontic treatment was assessed by interview and copies of orthodontic case notes obtained from the orthodontists. Muscular endurance was defined as the time the individual was able to bite with 50 per cent of maximal bite force until pain or obvious discomfort arose. The following psychological measures were completed by subjects prior to clinical examination: The Life Events Inventory (Cochrane and Robertson, 1973), General Health Questionnaire 30 (Goldberg, 1978), Eysenck Personality Inventory—Neuroticism, and Rosenberg Self-Esteem Scale.

RESULTS: Unweighted, as well as weighted, PAR values were significantly higher in subjects with the most severe dysfunction. Few associations between separate malocclusions or tooth contact pattern on mandibular movements were otherwise found. TMD and non-TMD subjects did not differ significantly with regard to orthodontic treatment or extraction of teeth. A comparison of muscular endurance revealed

a greater proportion of subjects with low endurance in those with TMD. There was no significant effect on the stress levels experienced during the previous year in the TMD group. Significant associations between TMD and general health and psychological well-being as well as the personality dimension of neuroticism and self-esteem were found.

CONCLUSION: Malocclusion and tooth contact pattern seem to have a fairly small influence on the development of TMD. Clearer associations were found between TMD and muscular endurance as well as psychological well-being, neuroticism, and self-esteem.

51 AN OVERVIEW OF THE DEVELOPMENT OF THREE DIMENSIONAL IMAGING: 2D–3D–4D

J P Moss

SHELDON FRIEL MEMORIAL LECTURE

Orthodontics and oral surgery are being revolutionized by the introduction of three-dimensional (3D) non-invasive imaging. Over the past 20 years the Medical Imaging Department of University College London has developed optical surface scanning and the parallel development of 3D computer tomographic (CT) magnetic resonance imaging (MRI) and ultrasound scanning. These will be briefly reviewed and their value to the orthodontist demonstrated. The developments of the fixed, linear, and handheld scanners have proved useful in orthodontics. The most important advances in scanning have been the processing of the data. The programmes that are used both in imaging and in the use of the data open a new window of usefulness for the clinician. The face can be viewed from any aspect and distances, areas, and volumes can be calculated.

The registration programmes enable the clinician to visualize the areas where the face of the patient is deficient or larger than normal by comparing them with norms for that age and sex. The results of treatment can also be demonstrated and the face again compared with norms. Growth can also be monitored over a period of time and as it is a non-invasive technique this can be done frequently thus giving the orthodontist an opportunity to treat the patient at the right period of growth.

The results of surgical intervention can be visualized and programmes have been written to predict and view the results of surgery in 3D, thus giving the orthodontist the opportunity to show the patient the results of surgery from any viewpoint. Similar programmes have been developed for forensic purposes by building up the soft tissue of the face over a scanned skull.

Programmes for the averaging of data are useful in comparing the results of treatment in a group of individuals and also when looking at the male and female facial differences. Are we able to detect the differences between males and females by looking at the faces alone? If we look at the faces of groups of normal patients at 5, 11, and 17 years and plot facial markers it is possible to show statistically that there is a difference in shape even at an early age.

It is possible to identify the shape of the surface of the face and to segment the face into areas of similar shape and to see the changes of shape in the face as the result of age. These programmes also enable the clinician to identify the shape of the face in schizophrenia and identify some of the features of the face that seem to be genetically determined from those which are more environmentally affected.

52 ASSOCIATION BETWEEN STABILITY, SATISFACTION, AND TEMPOROMANDIBULAR DISORDERS IN BORDERLINE CLASS III SUBJECTS

V E Myller¹, P Pirttiniemi¹, T Peltomäki², Departments of Orthodontics, ¹University of Oulu and ²University of Turku, Finland

AIM: To determine any associations between relapse, patient satisfaction, and temporomandibular dysfunction (TMD) in borderline Class III patients treated either surgically or by a combined orthodontic-surgical approach. **SUBJECTS AND METHOD:** Thirty adult Class III patients with an anterior crossbite treated orthodontically ($n = 15$) or orthodontic-surgically ($n = 15$) with equal cephalometric values in both groups. Standard cephalograms before and after treatment and at least 3 years out of retention were digitized and analysed with the dentofacial planner program. A clinical examination with registration of Helkimo's TMD-index and a multilevel questionnaire were used to determine patient satisfaction and recognition of relapse after treatment.

RESULTS: In surgically treated patients there was correlation between sagittal mandibular relapse and subjective feeling of relapse and satisfaction. In orthodontically treated patients there was a significant correlation between incisor relapse and subjective feeling of relapse, clinical dysfunction-index, and canine-guidance. In both groups the subjective feelings correlated strongly with measured relapse changes.

CONCLUSION: Surgically treated patients were satisfied with the treatment results in spite of some relapse and some symptoms. The ability of orthodontically treated patients to recognize relapse was found to be highly sensitive. Taken together, it is noteworthy how very accurate the patients' perceptions were concerning occlusal stability.

53 USE AND ABUSE OF DIAGNOSTIC TOOLS

S Palla, Department of Masticatory Disorders and Complete Dentures, University of Zurich, Switzerland

KEYNOTE ADDRESS

In the field of craniomandibular disorders (CMD), the topic of use and abuse of diagnostic tools has been and still is a matter of discussion. One of the reasons is certainly due to

the fact that the clinical examination has poor reliability and lacks the sensitivity and specificity needed to make a correct diagnosis. Therefore, several diagnostic tests, for instance electromyography, jaw tracking, axiography, tomography, and imaging have been proposed, based on diagnostic hypotheses or observations of a disturbed masticatory function in CMD patients. Unfortunately, despite the claims about diagnostic validity, several studies and reviews highlight the lack of scientific evidence to substantiate their diagnostic validity and therefore their usefulness in the clinic.

This lecture will focus on the problems connected with diagnostic tests, the difference between diagnosis and documentation, and point out which tests and when they may be indicated in the diagnostic process of CMD.

54 OUTCOME OF SURGICAL CLASS II MANDIBULAR ADVANCEMENT

H Pancherz¹, C Erbe¹, K Hansen², Departments of Orthodontics, Universities of ¹Giessen, Germany and ²Gothenburg, Sweden

AIM: To assess the effects of surgical mandibular advancement on the dento- and skeleto-facial structures in the therapy of adults with Class II malocclusions.

SUBJECTS AND METHODS: Forty-six adults (mean age 25 years) with a skeletal Class II division 1 malocclusion and a positive overbite treated exclusively with a mandibular sagittal split osteotomy. For tooth alignment pre- and post-surgery fixed appliances were used. Analysis was carried out on lateral head films from before and after surgical/fixed appliance therapy with respect to: sagittal and vertical dental arch and skeletal jaw base relationships, hard and soft tissue profile convexity, and upper and lower lip position.

RESULTS: The overjet and overbite were reduced ($P < 0.001$) by 6.4 and 2.1 mm, respectively. The overjet reduction was a result of 4.1 mm (63 per cent) mandibular advancement, 1.3 mm (21 per cent) maxillary, and 1.0 mm (16 per cent) mandibular incisor position changes. SNB increased 2.1 degrees ($P < 0.001$) and ANB reduced 2.4 degrees ($P < 0.001$). The mandibular plane angle increased by 3.3 degrees ($P < 0.001$). Hard and soft tissue profile convexity was reduced ($P < 0.001$) by 4.5 and 3.2 degrees, respectively. The distances of the upper and lower lips to the E-line increased by 2.5 mm ($P < 0.001$) and 1.1 mm ($P < 0.05$), respectively.

CONCLUSIONS: Clinically in these subjects no dramatic dento- or skeleto-facial changes occurred during surgical Class II mandibular advancement. It is therefore speculated that in a comparable group of adults non-surgical treatment using the Herbst appliance would have resulted in similar effects especially on the facial profile (Ruf and Pancherz, 1999).

Ruf S, Pancherz H 1999 Dentoskeletal effects and facial profile changes in young adults treated with the Herbst appliance. *Angle Orthodontist* 69: 239–246

55 EXPERIMENTAL INTRAUTERINE TREATMENT OF CLEFT-LIKE DEFECTS: A THREE-DIMENSIONAL COMPUTER TOMOGRAPHIC EVALUATION

M A Papadopoulos¹, C Jannowitz², N A Papadopoulos³,
¹Department of Orthodontics, University of Thessaloniki, Greece, ²Institute of Experimental Oncology and Treatment Research and ³Department of Plastic and Reconstructive Surgery, Technical University of Munich, Germany

AIM: To evaluate four different intrauterine methods used for the correction of alveolar cleft-like defects by means of three-dimensional computer-tomographic (3D-CT) analysis in the sheep model.

MATERIAL AND METHOD: In 12 pregnant sheep an alveolar defect was created intrauterine between the 75th and 95th gestation day. For closure of the alveolar defect, a bone graft from the iliac crest ($n = 3$), from the ulna ($n = 2$), from the ulna in combination with an expanded polytetrafluoro-ethylene membrane ($n = 3$), and an implant of collagen-lyophilisate with the above membrane ($n = 4$) were used. The control group consisted of four fetuses. All 16 fetuses were evaluated after euthanasia between the 140th and 145th gestation day, by means of CT-scanning of each skull followed by 3D reconstruction. Finally, a method of 3D-CT cephalometric analysis was developed. Twelve variables were used in order to compare the left and right sides of the skull as well as the asymmetry of both sides between the experimental and control groups. Statistical analysis was performed by means of the SPSS software (level of significance: $P < 0.05$).

RESULTS: Intra-group comparisons revealed no statistically significant differences in the 12 variables used, between operated and non-operated skull-sides for all groups. The comparison between all operated animals with bone healing and all animals without bone healing also revealed no statistically significant differences. When comparing the animals with bone healing with the control group only one variable, and when comparing all operated animals (with or without bone healing) with the control group six variables (concerning the premaxilla) presented significant differences. **CONCLUSIONS:** Each of the four intrauterine treatment methods seems not to affect post-surgical maxillary growth. Furthermore, a tendency to superior normal growth of the premaxilla can be observed when bone healing occurs after foetal surgery.

56 MANDIBULAR REMODELLING FOLLOWING VERTICAL RAMUS DISTRACTION OSTEOGENESIS

T K Pedersen¹, S E Nørsgaard², T Kofod², Departments of
¹Orthodontics and ²Maxillofacial Surgery, University of Aarhus, Denmark

AIM: Vertical elongation of the short ramus has become a routine solution for the growth-disturbed mandible. The reactions and interactions during and after distraction

of bone and soft tissue are not fully clarified and are of importance for orthodontic and orthopaedic post-distraction treatment. Furthermore, the patterns of relapse and dentoalveolar compensation are not sufficiently known in growing individuals under these circumstances. The increased length of bone seems to be followed by a change in mandibular function which will cause remodelling in other regions of the mandible, not directly related to the distraction site. The change in occlusion will require development and growth in the dentoalveolar area that has to be planned and controlled. The aim of this study was to longitudinally evaluate the effect of vertical ramus distraction on mandibular morphology, especially the lower border and angular area, and the need for orthopaedic controlled decompensation.

SUBJECTS AND METHODS: Fourteen patients (10 females, four males) with a mean age of 15.2 years followed cephalometrically for one or more years after distraction. The distractions were carried out in accordance with a protocol for vertical ramus distraction. The treatments were therefore similar and the patients could be considered as a homogeneous group. Superimposition was carried out on lateral and frontal cephalograms taken before and after distraction and approximately one year after treatment.

RESULTS: Changes were seen in the mandibular angle and remodelling was found especially in the angular area.

CONCLUSION: Long-term remodelling of the mandible occurs after vertical ramus distraction and should be considered when treatment is planned to include bone distraction.

57 LOWER INCISOR HYPODONTIA WITH RECESSIVE MODE OF INHERITANCE

S Pirinen, A Kentala, S Arte, Department of Pedodontics and Orthodontics, University of Helsinki, Finland

AIM: To describe a new form of hypodontia/oligodontia. Congenitally missing teeth mostly have a genetic background and the gene mutations causing hypodontia/oligodontia are at the moment intensively studied. Mutations in the *MSX1* and *PAX9* genes are known to cause missing teeth with autosomal dominant inheritance. A newly recognized condition where lower incisors are congenitally missing and in which the condition seems to be autosomally recessively inherited will be described.

SUBJECTS AND METHOD: Forty-three Finnish patients were diagnosed with this condition as a result of a nationwide questionnaire to dentists. Patients and family members were examined clinically and with panoramic radiographs. Family pedigrees were constructed with the help of church registers. DNA samples were obtained.

RESULTS: The condition was seen in siblings in four families. The male/female ratio was 1.05. The corrected ratio of affected children in the sibships was 0.22. In the case of 23/31 index cases the maternal and paternal ancestors originated from the same rural area. In most patients three to four permanent lower incisors and upper lateral incisors were missing and in 53 per cent corresponding deciduous teeth had been missing or peg-shaped. Other permanent and

deciduous teeth were also missing, most commonly second premolars. A large proportion of the patients (55 per cent) reported allergies, atopic skin, and asthma diagnosed by a doctor. Atopy was confirmed by serum IgE values in 37 per cent. No mutations were found in known candidate genes.

CONCLUSIONS: A new type of hypodontia, named RIH, has been described. Genealogical data strongly point towards autosomal recessive inheritance. Similar individual cases have been reported from other countries, but RIH may be over-represented in Finland.

58 BONE TO IMPLANT CONTACT OF TITANIUM MICROSCREWS FOR ORTHODONTIC ANCHORAGE

T M Präger, E A Holtgrave, Department of Orthodontics, University Hospital Benjamin Franklin, Freie Universität Berlin, Germany

AIM: Implants may provide sufficient anchorage for intrusion of lower incisors especially in periodontally involved dentitions. The holding power of immediately loaded screw implants used as orthodontic anchorage devices depends on the friction between bone and screw and consequently on the bone to implant contact. The aim of this study was to investigate the main area contributing to the holding power of screw implants in the anterior mandible.

MATERIAL AND METHODS: Twelve microscrews (diameter 1.5 mm, length 7 mm, made of commercially pure titanium) were inserted into the anterior region of 12 human cadaver mandibles. Undecalcified thin bone sections of the anterior region were made and stained with toluidine blue using the von Donath technique. Cortical thickness and bone to implant contact were microscopically investigated using the image C-computer programme. The Student's *t*-test was performed to analyse the differences between the cortical and the cancellous bone.

RESULTS: The thickness of the cortical layer was 2.04 mm (± 0.79) in the examined region. The bone to screw contact was 76.44 per cent (± 13.43) in the cortical bone and 43.48 per cent (± 22.49) in the cancellous bone. The 95 per cent confidence interval for the bone to implant contact enclosed 69.54–83.34 per cent in the corticalis and 35.38–51.58 per cent in the spongiosa. The bone to implant contact was significantly higher in the cortical bone than in the spongiosa.

CONCLUSION: Cortical anchorage plays a principal role for the holding power of micro-implants. Avoiding extension of the screws into the spongy bone by shortening the implant length would only modestly reduce the holding power but minimize the danger of root damage.

59 DETECTION OF EARLY ENAMEL DEMINERALISATION ADJACENT TO ORTHODONTIC CLEATS USING QUANTITATIVE LIGHT-INDUCED FLUORESCENCE

I A Pretty, N Pender, S M. Higham, Department of Clinical Dental Sciences, University of Liverpool, England

AIM: To determine whether quantitative light-induced fluorescence (QLF) could detect very early demineralization and remineralization longitudinally adjacent to orthodontic cleats in an *in vitro* model.

MATERIAL AND METHODS: Thirteen extracted human premolars were selected following an examination to determine that they were free from caries, restoration, extraction damage, or other enamel malformation. Each tooth was sectioned in a sagittal plane to produce two paired half-teeth to which a half cleat was bonded to the buccal with Transbond (3M, USA). Care ensured no composite flash or etched enamel extended beyond the cleat. Transparent nail varnish was placed over the tooth surface leaving exposed enamel windows adjacent to the coronal and gingival aspects of the cleat. Each half-tooth was then placed into the lid of an Eppendorf tube (2 ml) using dental wax, and randomly assigned to either control (distilled water) or experimental (lactic acid demineralizing buffer, pH 4.5). Digital photographs and QLF baseline images were taken. The tubes were then mounted into a rotating holder and left for 24 hours. QLF and digital photographs were taken, the solutions refreshed, and the teeth returned. This was continued every 48 hours for 288 hours. At that time the lactic acid buffer was replaced with a remineralizing solution (artificial saliva, fluoride, calcium) and the experiment continued with weekly images. QLF were analysed with ΔQ at the 5 per cent threshold.

RESULTS: Baseline ΔQ (mean $\pm$ SD) was 0.1 (± 0.16), which increased with each examination, 24 hours 5.2 (± 1.8), to 288 hours 68.2 (± 15.7). No change was observed in the control teeth. Following remineralization ΔQ values decreased, 7 days 65.6 (± 16.27), to 49 days 38.6 (± 14.4). Analysis of the photographs demonstrated that QLF detected sub-clinical lesions.

CONCLUSION: This initial pilot study has demonstrated the potential for QLF to longitudinally monitor de- and remineralization of enamel adjacent to orthodontic cleats *in vitro*.

60 AGE EFFECT ON ORTHODONTIC TOOTH MOVEMENT IN RATS

Y Ren, J C Maltha, Department of Orthodontics and Oral Biology, University of Nijmegen, The Netherlands

AIM: To describe orthodontic tooth movement in rats of different ages. The background is the clinical finding that orthodontic procedures in adults are often more time-consuming than in adolescents.

MATERIAL AND METHODS: Thirty young rats, aged 6 weeks, and 30 adult rats, aged 9–12 months. A standardized orthodontic appliance was placed on one side of the maxilla in all animals. All three molars were moved, as one unit, in a mesial direction by a continuous force of 10 cN exerted by a superelastic Sentalloy® coil spring. The other side of the maxilla served as the control. Active tooth movement was performed for 12 weeks. The distances between the incisors and the first molars on both sides were determined at regular time intervals by intra-oral measurements with a digital calliper. Experimental tooth movement was calculated as the

difference in movement between the experimental and control side. Time displacement curves were constructed and divided into a non-linear and linear phase. Statistical evaluation was performed on the differences between the two phases and between the age groups by *t*-tests for paired and independent measurements, respectively.

RESULTS: The total distance over which the molar unit moved was significantly larger in the young than in the adult rats for all time points ($P < 0.001$). In the first three weeks, the rate of experimental molar movement was significantly greater in the young animals than in the adults ($P < 0.001$). After this initial period, however, the rate was the same in the young and adult animals ($P = 0.32$).

CONCLUSIONS: Initial orthodontic tooth movement in young individuals is faster than in adults. Once tooth movement has reached the linear phase, the rate of movement in both age groups is the same. This indicates that the bone remodelling capacity in adults and young individuals is comparable. The longer treatment period in adults is mainly caused by a slower initial tissue reaction.

61 MEASURING THE COST-EFFECTIVENESS OF ORTHODONTIC TREATMENT

S Richmond, Dental School, University of Wales College of Medicine, Cardiff, Wales

KEYNOTE ADDRESS

AIM: The aim of this prospective study was to develop and use a measure to assess cost-effectiveness in orthodontic care.

SUBJECTS AND METHOD: Eighteen orthodontists, six from each of three different services, General Dental Service (GDS), Hospital Dental Service (HDS), and Community Dental Service (CDS). One hundred patients were followed from acceptance to completion of orthodontic care. Questionnaires were completed by the orthodontic practitioners, patients, and accompanying persons to evaluate the cost of treatment and perceptions of treatment need, process, and outcome. The cost of orthodontic provision was also evaluated for each practitioner and each service. The cost from the patient point of view was also calculated. The orthodontic treatment complexity, outcome and need were assessed using the Index of Complexity, Outcome and Need. Five cost-effectiveness models were employed.

RESULTS: The patient costs ranged from €243 in the CDS to €313 in the HDS. Total treatment time was 219 minutes in the GDS compared with 529 minutes in the HDS. The costs for individual practitioners ranged from €567 to €2156. The number of acceptable finishes as a proportion of starts ranged from 15 to 87 per cent. A cost-effective model based on the proportion of cases needing treatment and having acceptable outcomes indicated that there were cost-effective and cost-ineffective orthodontists in each service.

CONCLUSIONS: A measure has been developed and employed successfully to assess cost-effectiveness in orthodontic care. The least expensive and most cost-effective provider of orthodontic care is the CDS.

62 DEFINING THE ANTERIOR LIMIT OF THE DENTITION WITH IMPLANT ANCHORAGE

W E Roberts, W F Hohlt, P M Schneider, Indiana University, Indianapolis, USA and University of Melbourne, Victoria, Australia

KEYNOTE ADDRESS

This keynote lecture will report on the clinical experience of three clinicians in defining the anterior limit of the dentition with implant anchorage.

A prospective series of 56 patients with partially edentulous malocclusions were treated with endosseous implant anchorage. All patients had acquired malocclusions that were associated with trauma, pathology, or a history of missing teeth due to congenital absence or extraction. The report will concentrate on functional compensations for the loss of posterior teeth, resulting in over-closure of the mandible.

In descending order the most common acquired disorders were: (1) retrusive mandible; (2) flaring and spacing of incisors; (3) attrition of the anterior teeth; and (4) anterior crossbite. All of these scenarios were associated with both a decreased lower face height and vertical dimension of occlusion (VDO). Treatment planning of the anterior limit of the dentition focused on reversing the functional compensations diagnosed. The most common treatment plan was: (1) VDO opened to the limit of lip competence with an interocclusal orthotic or a maxillary (Mx) bite plate; (2) mandibular incisal edges positioned 2–4 mm anterior to the A–Pog line; (2) Mx incisor exposure of 2–4 mm; (3) interincisal angle to allow about 30 degrees of incisal guidance; (5) Class I canine relationship; (6) alignment of the dentition according to the prescribed incisal position. To avoid compromising the desired position of the incisors, all cases were treated with implant anchorage (implant-supported prostheses and/or retromolar implants) to protract the buccal segments.

With regard to attaining the most desirable aesthetics and functional outcomes, it was concluded that: (1) positioning of the anterior segment of the mandible at the anterior limit of the dentition was the most critical aspect of treatment planning; and (2) osseointegrated implants were essential anchorage units.

63 ANTERIOR OPEN BITE WITH OVERBITE—A PROGNOSTIC FACTOR FOR TREATMENT SUCCESS AND STABILITY?

S Ruf, N Askeridis, Department of Orthodontics, University of Giessen, Germany

AIM: To assess the treatment success and stability in terms of post-treatment inter-incisor contacts in subjects with pre-treatment anterior open bite (AOB) with overbite.

SUBJECTS AND METHOD: From the total patient material of the Department of Orthodontics of Giessen University all subjects with an AOB with overbite were selected by analysing the pre-treatment dental casts and lateral

cephalograms. The inclusion criteria were (1) complete eruption of the incisors, (2) missing inter-incisor contacts (all anterior teeth) with a minimal distance of 1 mm between them, (3) an overbite of at least 1 mm, (4) no missing incisors, and (5) no previous orthodontic treatment. Fifty-five subjects met the criteria. Dental casts and lateral cephalograms from before treatment, after active treatment, and at the end of retention were analysed to assess sagittal and vertical dentoskeletal morphology as well as the changes during and after treatment. Data concerning possible habits (such as tongue thrust, atypical swallowing, and habitual mouth breathing) and the orthodontic appliances used were recorded.

RESULTS: Eighty five per cent of the subjects with AOB with overbite exhibited one or more habits. In the total patient material inter-incisor contacts were present in 51 per cent of the subjects after treatment and in 40 per cent at the end of the retention period. Treatment success after active treatment was independent of the malocclusion severity, the orthodontic appliance used, and the existence or non-existence of habits. Treatment stability, however, depended exclusively and markedly on existing habits ($P < 0.01$). The percentage of individuals with inter-incisor contacts at the end of the retention period was 100 per cent for individuals without habits, 60 per cent for subjects with one habit, and 43 per cent for subjects with two or more habits.

CONCLUSION: AOB with overbite is an indicator for existing habits and as such a prognostic factor for the long-term stability of inter-incisor contacts. The prognosis deteriorates with the involvement of an increased number of habits.

64 IS THE NEED OF LATER ORTHOGNATHIC SURGERY PREDICTABLE IN CHILDREN WITH CLASS III MALOCCLUSIONS?

G Schuster¹, A Stellzig-Eisenhauer², Departments of Orthodontics, ¹Frankfurt University and ²Heidelberg University, Germany

AIM: The literature does not provide an accurate model to predict the later necessity for orthognathic surgery. Since not all of these patients are candidates for later surgical correction, assessment and selection remains a main issue in diagnosis and treatment planning. The aim of this study was to analyse the predictive power of classifying Class III children before puberty into patients who could be treated by orthopaedic/orthodontic therapy alone from those who would require orthognathic surgery.

SUBJECTS AND METHOD: To obtain a robust model, 88 patients with a Class III malocclusion were entered in a multicentre-study (Orthodontic Departments of the Universities of Frankfurt, Heidelberg, and Würzburg). Grouping into orthopaedic/orthodontic patients ($n = 65$) and surgery patients ($n = 23$) was carried out based on their records after puberty (mean age: 17 years 3 months). Twenty linear, proportional, and angular measurements were based

on the cephalograms of the patients before puberty (mean age: 9 years 8 months). Stepwise discriminant analysis was applied to identify those dentoskeletal variables, which provided the best group separation.

RESULTS: The discriminant function model was highly significant ($P < 0.001$), classifying 93.2 per cent of the patients correctly. The extracted variables were: Wits appraisal, inclination of the palatal plane, and individualized inclination of the lower incisors. The resulting equation was: Individual score = $2.277 + 0.492 \cdot \text{Wits} + 0.116 \text{ NL-NSL} - 0.58 [180 - (1 - \text{ML})] - (1 - \text{ML}_{\text{ind}})$.

CONCLUSION: Using discriminant analysis correct classification of prepubertal Class III malocclusion children into non-surgery and surgery patients succeeded to a very high degree. From all variables, the Wits appraisal was the most decisive parameter.

65 A PROSPECTIVE STUDY OF THE SOFT TISSUE EFFECTS OF TWO TYPES OF TWIN BLOCK FUNCTIONAL APPLIANCES

A A Sharma, D Gill, R T Lee, Department of Orthodontics, The Royal London Hospital, England

AIMS: To compare the soft tissue treatment changes produced by the Twin Block (TB) and Mini Block (MB) functional appliances in two and three dimensions.

SUBJECTS AND METHOD: Seventy patients with Class II division 1 malocclusions were matched for age and gender and then randomly allocated to either the TB or MB group. Sixty patients (40 males, 20 females) completed the study, which had a median treatment time of 1.1 years. Thirty patients were treated with the TB and 30 with the MB. The MB was gradually advanced and had a reduced block height. Active treatment lasted nine months, followed by a three month relapse phase in which no appliances were worn. Soft tissue changes were assessed by lateral cephalograms and laser scans taken at the start of treatment and at 12 months. Additional laser scans were taken at three and nine months into treatment.

RESULTS AND CONCLUSIONS: There was a significantly greater protrusion of soft tissue pogonion (ST Pog to S-Vert) in the TB group (4.0 versus 1.8 mm) whilst the soft tissue total anterior face height increased less in the TB group (3.1 versus 4.3 mm). These values closely matched the underlying skeletal changes. During the three-month relapse period there was an approximate 1.0 mm loss of protrusion of soft tissue pogonion in both groups. There were no significant transverse changes. Most measurements were associated with large ranges, demonstrating variability in patient response to treatment.

66 BITE FORCE IN PRE-ORTHODONTIC CHILDREN WITH UNILATERAL CROSSBITE

L Sonnesen, M Bakke, B Solow, Departments of Orthodontics and Oral Function and Physiology, University of Copenhagen, Denmark

AIM: To examine bite force, symptoms and signs of temporomandibular disorders (TMD) and teeth in contact in pre-orthodontic children with unilateral posterior crossbite as compared with an age- and sex-matched control group.

SUBJECTS AND METHODS: Fifty-two children aged 7–13 years, 26 pre-orthodontic children with unilateral posterior crossbite (crossbite group), and 26 children with neutral occlusion (control group). Unilateral bite force was measured at the first molar by means of a pressure transducer. In addition, signs and symptoms of TMD and the number of teeth in contact in the intercuspal position were recorded.

RESULTS: In both groups, the maximum bite force increased significantly with age and with increasing stage of dental eruption, but the bite force in boys and girls did not differ significantly. There were no significant differences in bite force between sides, but bite force was significantly smaller in the crossbite group than in the controls ($P < 0.001$). Regression analysis showed that stage of dental eruption ($P < 0.001$), number of teeth with occlusal contact ($P < 0.01$), and unilateral crossbite ($P < 0.001$) were the only variables significantly correlated with bite force. The number of teeth in contact was significantly smaller in the crossbite group than in the controls ($P < 0.05$) and the frequency of muscle tenderness was significantly higher in the crossbite group than in the controls ($P < 0.05$).

CONCLUSION: Differences in muscle function associated with unilateral crossbite lead to a significantly smaller bite force in the crossbite group compared with the controls, and this difference did not diminish with age and development. These findings indicate that early treatment of unilateral posterior crossbite is advisable to optimize conditions for function.

67 COMPARISON OF CLINICAL AND MAGNETIC RESONANCE IMAGING DIAGNOSES OF PATIENTS WITH TEMPOROMANDIBULAR DYSFUNCTION

S Üşümez, F Oz, E Guray, Department of Orthodontics, Selçuk University, Konya, Turkey

AIM: To evaluate the diagnostic accuracy of a well-defined clinical examination for diagnosing anterior disc displacement with and without reduction.

SUBJECTS AND METHOD: Forty patients with a history of temporomandibular dysfunction (TMD) were examined according to well-defined routine criteria. The examination included detailed history taking, standardized clinical head and neck examination, including measurements of the range of motion, palpation of the temporomandibular joints and muscles of mastication for pain, and auscultation of joint sounds. Magnetic resonance images (MRI) of the joints were used as the 'gold standard'.

RESULTS: Diagnostic accuracy of the clinical examination was 83 per cent for determining normal disc-condyle relationship, 72 per cent for diagnosing anterior disc displacement with reduction (DDR), and 81 per cent for diagnosing

anterior disc displacement without reduction (DDNR). The likelihood ratio (LR) values of clinical tests to determine DDR and DDNR were also calculated. The highest LR for DDR was that of co-existence of clicking, deviation and pain, while co-existence of crepitation, deflection, and pain demonstrated the highest LR value for DDNR.

CONCLUSION: Anterior disc displacement can be diagnosed with considerable accuracy using only a well-defined clinical examination. Therefore, not all patients with TMD symptoms require an MRI examination before treatment.

68 EMOTIONAL STRESS AFFECTS ROOT RESORPTION AND EXPERIMENTAL TOOTH MOVEMENT IN RATS

V Vandevska-Radunovic¹, R Murison², R Jonsson³,

¹Department of Orthodontics, University of Oslo,

²Department of Medical and Biological Psychology and

³Broegelman Research Laboratory, University of Bergen, Norway

AIM: To investigate the possible effect of emotional stress on root resorption and tooth displacement during orthodontic tooth movement in rats.

MATERIALS AND METHOD: A total of 52 mol:WIST rats were used. They were divided into three active and one control group. The first active group ($n = 16$) was subjected to stress and orthodontic treatment (SOT); the second group ($n = 16$) had no stress, only orthodontic treatment (NSOT); the third group ($n = 16$) was subjected to stress without orthodontic treatment (SNOT). Each group was subdivided into four subgroups ($n = 4$) corresponding to the treatment periods of 3, 7, 13, and 21 days. An orthodontic appliance was inserted on the first, right maxillary molar and exerted a mesial force of 0.5 N. The animals subjected to stress were placed in a shock-box at random. At the end of each treatment the animals were sacrificed and the jaws were excised, fixed, and demineralized. Cellular cementum, taken as a measure for apical root resorption, and tooth displacement were measured on sagittal serial sections (20 μ m) using the Cue-3 Image Analyzer. Group differences in root resorption and tooth movement were evaluated by ANOVA.

RESULTS: At 3 days, there were no significant differences in root resorption. As expected, the groups with orthodontic appliances demonstrated significant tooth displacement compared with the other two groups. At 7 and 13 days, the greatest and most significant root resorption was seen in the SOT group when compared with the SNOT and control groups, but not when compared with the NSOT group. Tooth movement was significantly more advanced in the NSOT group compared with all other groups. This significance was maintained at 21 days, but now significant differences in root resorption were only found between the SOT and SNOT groups.

CONCLUSIONS: Emotional stress affects both root resorption and tooth displacement during orthodontic tooth movement in rats.

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69 FUNCTION AND AESTHETICS IN TREATMENT PLANNING

K Vargervik, University of California, San Francisco, USA

KEYNOTE ADDRESS

Principles of growth and normal growth patterns will be described followed by examples of abnormal growth patterns and disproportions in facial and jaw structures. Aetiological factors will be discussed, and the potential for interceptive and corrective treatment without surgery will be evaluated in principle and by findings from experimental studies and case analyses.

Efficacy of surgical versus non-surgical treatment will be introduced for discussion as well as the issue of imposing our own image of attractiveness on our patients.

Even in borderline cases both the surgeon and the orthodontist, and other team members as needed, should agree on the chosen treatment approach. In cases where treatment needs require the combination of orthodontics and surgery, the best treatment outcome is achieved when the surgeon and the orthodontist work together closely in treatment planning and post-treatment follow-up.

70 INITIAL WIDTH OF THE CLEFT RELATED TO TREATMENT OUTCOME IN UNILATERAL CLEFT LIP AND PALATE PATIENTS

K Wiggman, V Brattström, G Semb, Eastmaninstitutet, Stockholm, Sweden and Oslo, Norway

AIM: To investigate whether the initial width of the cleft is correlated to maxillary growth and length of orthodontic treatment in patients born with a unilateral cleft of the lip and palate.

MATERIAL AND METHODS: Two groups of consecutive patients following different treatment protocols were studied. Apart from lip closure and palate closure practised in both groups, pre-surgical orthopaedics and primary bone grafting were used in one group ($n = 20$) and secondary bone grafting in the other group ($n = 26$). The transversal width of the cleft was measured with a digital calliper on study casts, taken close to birth. The width was measured at three different loci: anterior, middle, and posterior. These measurements were correlated to variables describing treatment outcome at 17 years of age. On lateral cephalograms the length, protrusion, and inclination of the maxilla were studied. From medical records the number of teeth showing agenesis, the need for orthognathic surgery, and length of orthodontic treatment with fixed appliance were included.

RESULTS: The width of the cleft, expressed as a percentage of the total palatal width, varied. In the primary bone grafting group the width of the cleft was 31–59 per cent in the posterior part and 20–60 per cent in the middle part. In

the secondary bone grafting group the initial width of the cleft was 35–50 per cent in the posterior part and 0–45 per cent in the middle part. No correlation was found between the initial width of the cleft and the variables studied.

CONCLUSION: The initial width of the cleft does not seem to influence the final treatment outcome regarding maxillary growth, the number of teeth showing agenesis, or the length of orthodontic treatment.

71 CORRELATION OF REPLICATING CELLS AND OSTEOGENESIS IN THE GLENOID FOSSA DURING STEPWISE ADVANCEMENT

L Wong, A B M Rabie, U Hägg, Orthodontics, University of Hong Kong, China

AIM: To quantify the number of replicating mesenchymal cells and to correlate it to the amount of new bone formed in the glenoid fossa during stepwise advancement.

MATERIAL AND METHODS: Two hundred and fifty female Sprague-Dawley rats, 35 days old, were randomly divided into 10 control groups ($n = 5$) and 20 experimental groups ($n = 10$). Fifty rats from the stepwise experimental group received initial 2 mm advancement with another 1.5 mm advancement on day 30 by the addition of veneers. On days 3, 7, 14, 21, 30, 33, 37, 44, 51, and 60 the rats were sacrificed. One hour before, all rats were injected with bromodeoxyuridine (BrdU) intravenously. Tissue sections of 7 μ m were cut through the glenoid fossa sagittally and stained with anti-BrdU antibody to evaluate the number of replicating mesenchymal cells.

RESULTS: During the first advancement, the number of replicating cells in the posterior region of the glenoid fossa showed a significant increase compared with natural growth, but a significant decrease when compared with the one step. On the second advancement, however, an increase in the number of replicating cells was observed on day 37 with a subsequent and significant increase in bone formation on day 44.

CONCLUSION: Forward positioning of the mandible conducted in a stepwise fashion increases the number of replicating mesenchymal cells in the glenoid fossa. However, a minimum threshold of strain must first be exceeded before these mesenchymal cells can differentiate to ultimately form new bone.

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72 ORTHODONTIC MANAGEMENT BEFORE AND AFTER DISTRACTION OSTEOGENESIS

Y Zhou¹, X Wang¹, R L Vanarsdall², ¹Peking University School of Stomatology, Beijing, China and ²University of Pennsylvania School of Dental Medicine, Philadelphia, USA

AIM: Since the initial application of distraction osteogenesis (DO) to the human mandible by McCarthy, DO has been used for gradual bone lengthening of the maxilla and mandible in patients with cleft lip and palate, hemifacial microsomia, and other craniofacial anomalies. This presentation provides guidelines for orthodontic management before and after DO.

SUBJECTS AND METHODS: Twelve patients (5–41 years of age) who underwent DO, six for the maxilla, and six for the mandible. The pre- and post-distraction orthodontic treatment was evaluated.

RESULTS: (1) Pre-distraction orthodontics involves simple alignment of dental arches, and preparation of the dentition for distraction. (2) Post-distraction orthodontics is more

complicated and difficult. The primary task is to position the opened posterior teeth into occlusion as soon as possible by light force vertical elastics. At the same time, some cross tooth elastics may be necessary for correction of posterior crossbite. (3) Expansion of the upper arch may be needed in patients because of dental arch constriction. (4) Class II or III elastics are required for finishing and detailing of the dentition.

CONCLUSION: DO offers an alternative approach for the correction of craniofacial and large dentofacial deformities. Pre- and/or post-distraction orthodontics are a necessity for patients undergoing DO. Post-distraction orthodontics is more complicated and important for an excellent treatment outcome.

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