

ABSTRACTS

OF LECTURES

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

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1 PERIODONTAL CONSEQUENCES OF ORTHODONTIC TOOTH MOVEMENT AND ORTHOGNATHIC SURGERY

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KEYNOTE ADDRESS

Current technology allows extreme orthodontic tooth movements. Similarly, almost any orthognathic surgical correction is technically possible. The limitations are related to outcome projects regarding aesthetics and stability as well as the risk of iatrogenic effects associated with the different procedures.

Orthodontic tooth movements along the dental arch do not *per se* represent a risk of periodontal attachment loss, regardless of age, initial attachment level, and amount of tooth movement. The crestal bone follows the attachment level, and any destruction is due to plaque associated with periodontal breakdown, reflecting a combination of oral hygiene performance of the patient, the periodontal disease activity, and the resistance to periodontal destruction. In contrast, the crestal bone may not follow the connective tissue attachment during extreme orthodontic expansion. The mechanism may be that the structural limit for the osteogenic progenitor cells to form new bone is exceeded, resulting in a long supra-crestal connective tissue attachment prone to recession. The mechanics for attachment loss following orthognathic surgery is development of avascular necrosis due to blood flow disturbances during the surgical procedure. The risk may, therefore, be limited to Le Fort osteotomies.

2 DYNAMIC PHOTO-ELASTIC STRESS ANALYSIS OF INITIAL ALIGNMENT ARCHWIRES

S A Badran, J F Orr, D J Burden, Orthodontic Division, Queen's University, Belfast, UK

AIMS: To evaluate the stresses transmitted to the roots of the teeth by initial alignment archwires.

MATERIAL: The development of the gelatine photoelastic orthodontic model has been reported elsewhere (Clifford *et al.*, 1999). Photo-elastic analysis is a widely employed optical technique for examining and measuring stress distributions. A full mandibular arch of previously extracted human teeth was constructed with 8 mm of crowding in the lower incisors. Five initial alignment archwires were compared in this study, one multistrand stainless steel (0.015-inch, Wildcat, GAC), two non-superelastic (SE) nickel titanium wires (0.014 and 0.016-inch, Nitinol Classic, 3M Unitek), and two stress-induced SE nickel titanium wires (0.014 and 0.016-inch, Nitinol SE, 3M Unitek). Measurement of crown and root movements was completed using two manual SLR cameras, and a circular polariscope was used for photo-elastic stress analysis.

RESULTS: The NiTi SE archwires were found to transfer less stress to the roots of the teeth than the Nitinol archwires. The stress transmitted to the roots of the teeth by the multistrand stainless steel archwire (0.015-inch Wildcat) was intermediate between the Nitinol and the NiTi SE archwires. The only significant differences detected were between the 0.016-inch Nitinol Classic and the Nitinol SE archwires (0.014 and 0.016-inch). The 0.016-inch Nitinol Classic archwires had higher mean fringe orders (stress) than the 0.014-inch NiTi SE ($P < 0.01$) and the 0.016-inch NiTi SE ($P < 0.05$).

CONCLUSION: Although the SE archwires transfer less stress to the roots, the question remains whether the small differences in the stress levels detected are clinically important.

Clifford P M, Orr J F, Burden D J 1999 The effects of increasing the reverse curve of Spee in a lower archwire examined using a dynamic photo-elastic gelatine model. *European Journal of Orthodontics* 21: 213–222

3 A STUDY OF THE FACIAL MORPHOLOGY OF TWINS

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AIMS: To assess the genetic influence on anteroposterior and vertical facial parameters, using monozygotic and dizygotic twins.

SUBJECTS: Ten pairs of monozygotic twins (5 male, 5 female, mean age 11.9 years), and 10 pairs of same-sex dizygotic twins (3 male, 7 female, mean age 12.1 years) were studied.

METHOD: Data acquisition was by three-dimensional optical surface scanning of the faces of the twins. Eighteen landmarks were placed and inter-landmark measurements of 28 facial parameters were recorded. The mean intra-pair differences for each parameter were compared between the monozygotic and dizygotic groups.

RESULTS: Significant ($P \leq 0.05$) genetic determination was found for left eye width, intercanthal width, nose height, and nose width. The within-pair differences for the monozygotic twins were larger for the anteroposterior than for the vertical parameters. The differences between the monozygotic and the dizygotic twins were also greater for the anteroposterior parameters. The concordance for vertical and anteroposterior facial parameters was found to be greater in monozygotic than in dizygotic twins. The concordance for vertical facial dimensions of the middle and lower anterior parts of the face was found to be greater than that for anteroposterior facial dimensions in monozygotic twins.

CONCLUSION: Vertical facial dimensions have a stronger genetic determination than the anteroposterior facial dimensions in this group of twins, which is the largest sample studied to date.

4 THE VARIABLE ANCHORAGE STRAIGHTWIRE TECHNIQUE IN DEEP OVERBITE CORRECTION

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AIM: To compare, retrospectively, the treatment effects between the variable anchorage straightwire (VAST) and the conventional straightwire (SW) technique.

SUBJECTS: Fifty-three Caucasian patients, mean age 13.5 years, with a diagnosis of post-normality or crowding and with an overbite of ≥ 3 mm and overjet of ≥ 4 mm treated by the same orthodontist with the VAST ($n = 31$) or SW ($n = 22$) technique, extraction or non-extraction.

METHODS: Cephalometric analysis according to Pancherz (1982) was carried out before and after treatment. Changes in overbite, overjet, active treatment time, number of scheduled and emergency visits were also recorded.

RESULTS: Generally the treatment time with the VAST technique was 4 months shorter, with fewer scheduled and emergency visits. The mean decrease in overbite was the same for both techniques, but the reduction in overjet was significantly greater with the VAST technique. When comparing the extractions cases, it was found that with the VAST technique lower facial height increased, the mandibular plane angle opened, the upper and lower first molars extruded and the central incisors retroclined more compared with the SW technique. In the non-extraction cases the tendency was the same but to a lesser extent.

CONCLUSION: The VAST technique, with its variation of tipping and translation of individual teeth and its adaptation to anchorage need, seems to result in shorter and more effective treatment in bite opening than the conventional SW technique.

5 THE EFFECTS OF A MODIFIED ACRYLIC BONDED RAPID MAXILLARY EXPANSION APPLIANCE AND VERTICAL CHIN CUP ON DENTOFACIAL STRUCTURES

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AIMS: To determine the dentofacial effects of a modified acrylic bonded rapid maxillary expansion (RME) appliance with vertical chin cup and a modified acrylic bonded rapid RME appliance in high angle patients in the permanent dentition with maxillary constriction and posterior crossbite. **SUBJECTS AND METHODS:** Twenty-five girls and nine boys in the permanent dentition with maxillary constriction. Lateral and frontal cephalometric radiographs and upper and lower study casts were taken prior to treatment (T1), at the end of the treatment (T2), and at the end of retention (T3). Seventeen subjects formed group 1 (RME with vertical chin cup) and 17 group 2 (RME). Twenty-nine measurements were made on the lateral and frontal radiographs and study casts. The data was evaluated as T1–T2, T2–T3, and T1–T3 using Wilcoxon matched-pairs signed-rank test.

Further comparison between the groups was undertaken using the Mann–Whitney *U*-test.

RESULTS: The maxilla moved forwards. Nasal, maxillary, upper anterior and lower posterior widths, and overjet increased. The upper molars were flared buccally in both groups. In addition, in group 2, the mandibular plane angle and lower face height increased due to vertical movement of the upper first molars and overbite reduction.

CONCLUSION: The use of a vertical chin cup with RME to prevent the negative vertical effects of the appliance is thought to be effective in patients who are vertically growing and who have maxillary constriction.

6 TOOTH SIZE VARIATION IN DENTITIONS WITH BUCCAL AND PALATAL MAXILLARY CANINE DISPLACEMENT

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AIM: To compare tooth size and maxillary lateral incisor morphology in subjects with palatally displaced canines with normal and late dental age, and to relate these findings to dentitions exhibiting buccally displaced canines and normally erupted controls.

MATERIAL: Maxillary dental casts and panoramic radiographs of 139 patients (58 with palatally displaced canines, 41 with buccally displaced canines, and 40 with normally placed canines).

METHODS: Mesiodistal and buccolingual measurements were made of the maxillary teeth. Maxillary lateral incisor anomaly was determined. Dental age was assessed, according to root development, from panoramic radiographs.

RESULTS: Tooth size and the frequencies of occurrence of lateral incisor abnormality and palatal canine displacement showed considerable sexual dimorphism. Significantly reduced mesiodistal dimensions in palatal displacement compared with controls were observed only in males with retarded dental development, notably lateral incisors and first premolars. Mesiodistally enlarged teeth were present in females with buccally displaced canines. The prevalence of lateral incisor anomaly increased with late dental development. Peg-shaped lateral incisors were frequently found adjacent to palatally displaced canines. Absence of lateral incisors was observed more commonly on the unaffected side in subjects with a unilateral palatal canine.

CONCLUSION: Tooth size reduction and enlargement varies in dentitions with palatally and buccally ectopic maxillary canines, according to dental age and to sex. Subjects with palatal canines are not usually characterized by crowding, although smaller teeth were found only in males with late dental development. Regarding buccal canine displacement, crowding may be associated with enlarged tooth size in females, while arch length may be the more important factor in males.

7 CLINICAL-TOMOGRAPHIC FEATURES OF TEMPOROMANDIBULAR JOINT INVOLVEMENT IN PATIENTS WITH JUVENILE RHEUMATOID ARTHRITIS

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AIM: To evaluate the incidence of temporomandibular joint (TMJ) involvement in different subtypes of juvenile rheumatoid arthritis (JRA) (pauciarticular, polyarticular, and systemic), to investigate the statistical correlation between symptoms, clinical signs, and tomographic modifications of the TMJs and to grade the type of morphological alterations.

SUBJECTS: Fifty-six consecutive patients with a mean age of 17.3 years (range 10–25 years; 42 females, 14 males) and mean disease duration of 10.4 years.

METHODS: Each patient was evaluated according to Helkimo's protocol (assessment of anamnestic dysfunctional, clinical dysfunctional, and occlusal indices) and a tomographic study. Ipocycloidal tomographies were first obtained using an axial radiograph and were graded using the Rohlin-Petersson scale (grades 0–5) according to the severity of erosive changes.

RESULTS: Radiological alterations were observed in 84 per cent of patients. All subjects with systemic and polyarticular onset JRA showed tomographic TMJ involvement. There was no significant correlation 0.57 ($P > 0.05$) between subjective symptomatology (iAnam) and clinical dysfunctional signs (iDisf) in the TMJs. In particular, the severity of the symptoms described by patients was generally lower than that of the severe morphological alterations of TMJs. Moreover, no correlation was found between iDisf and morphological alterations shown on the TMJ tomograms.

CONCLUSIONS: These results confirm the importance of clinical examinations in patients affected by JRA, even if they are asymptomatic, and also the need for tomograms even in subjects with only moderate clinical dysfunctions. These screening procedures are essential for early diagnosis of TMJ modifications in JRA.

8 CENTRIC CONDYLE POSITIONING IN BIMAXILLARY OSTEOTOMIES WITH AN INTERMEDIATE, TWIN OCCLUSAL SPLINT

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AIM: Centric condyle positioning with interocclusal splints is a standardized method in orthognathic surgery. In maxillary osteotomies, depending on the amount of maxillary impaction, mandibular autorotation occurs. In bimaxillary osteotomies mandibular autorotation leads to a vertical step in the osteotomized area, resulting in a change of load forces by masticatory musculature and a dysfunction of the temporomandibular joint. Based on this hypothesis

a new method of condyle positioning in bimaxillary osteotomies is presented.

SUBJECTS: During 1997–2000 combined bimaxillary surgery was performed in 169 patients with combined bimaxillary osteotomies in progenia with maxillary hypoplasia (123), circular open bite (32), and maxillary hypoplasia in patients with cleft lip and palate (14).

METHODS: In pre-operative planning, in addition to a primary occlusal splint and a thick intermediate occlusal splint, a second, thin intermediate occlusal splint was manufactured planning for mandibular autorotation after maxillary impaction.

RESULTS: Intra-operatively after maxillary osteotomy with intermediate occlusal splint positioning (thick intermediate occlusal splint), the mandible precisely rotated into the second, thin intermediate occlusal splint. The post-operative follow-up, a maximum of 40 months in all patients, confirmed the precise operatively determined occlusion without any post-operative condylar dysfunction.

CONCLUSION: This newly described method allows precise transfer of model surgery planning of the Le Fort I osteotomy to the patients as well as maintaining the precise position of the condyles throughout the entire surgical procedure.

9 HIGH-INTENSITY LIGHT-CURING OF A RESIN-MODIFIED GLASS-IONOMER

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AIMS: To evaluate, 15 minutes after bonding, the shear bond strengths of a resin-modified glass ionomer (Fuji Ortho LC) and a composite resin (Transbond XT) cured with two different light-curing units, a conventional visible light (Ortholux XT) and a xenon arc light (Aurys).

MATERIALS AND METHODS: Ninety freshly extracted bovine permanent mandibular incisors were randomly divided into six groups; each group consisting of 15 specimens. Two groups (one for each type of adhesive) were exposed to the visible light for 20 seconds (Transbond XT) and 40 seconds (Fuji Ortho LC), respectively, and used as controls. Among the remaining four groups, three were bonded with Fuji Ortho LC and cured with the xenon arc light for 2, 5, and 10 seconds, respectively, and the other group was bonded with Transbond XT and cured with the xenon arc light for 2 seconds. After bonding, all samples were stored in distilled water for 15 minutes and subsequently tested in a shear mode with an Instron machine. Statistical analysis (two-way ANOVA, Scheffé's and Chi-square tests) was performed.

RESULTS: The shear bond strength of the control group bonded with Transbond XT and cured with Ortholux XT was significantly higher ($P < 0.001$) than those of all the other groups tested. When evaluating the bond strengths of the groups bonded with Fuji Ortho LC, no statistically significant differences were found between the control group cured with Ortholux XT or those cured with Aurys for 2, 5,

and 10 seconds. No statistically significant differences were found between the bond strength of the composite resin cured with Aurys for 2 seconds and those of the resin-modified glass ionomer.

CONCLUSIONS: Compared with visible light-curing, the xenon arc light enables the clinician to significantly reduce the curing time of resin-modified glass ionomers, without affecting their shear bond strengths, immediately after bonding.

10 HYPODONTIA AND DENTAL AGE IN CLEFT AND NON-CLEFT SIBLINGS

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AIMS: To compare the occurrence of hypodontia in cleft-affected children and their non-cleft siblings in order to estimate the genetic contribution to both variables and dental age.

MATERIAL: Dental panoramic radiographs were collected from 54 cleft-affected children (aged 4.2 to 13.1 years), from 63 non-cleft siblings (aged 4.0 to 14.9 years), and from 250 non-sibling control children (aged from 4.0 to 14.9 years). A clinical examination of the oral cavity was performed for each individual, the dental panoramic radiographs were inspected for the absence of permanent teeth and the dental age was assessed according to the method of Demirjian (1972). Descriptive statistics were performed in order to test the distribution of the data and then unpaired *t*-, *F*-, and Chi-square tests were carried out.

RESULTS: Both the cleft and the sibling group showed a significantly higher frequency of hypodontia ($P < 0.05$) than the control group. However, no significant delay could be demonstrated for dental formation in the cleft children and their siblings, compared with the controls.

CONCLUSIONS: Genetic factors contributing to the formation of the cleft must be closely related to the genes responsible for dental hypodontia. The results also show that in this sample, no delay in dental formation could be demonstrated in the cleft-affected children compared with their siblings or a normal non-sibling population.

11 OSSEOINTEGRATION IN GROWING PATIENTS—A LONG-TERM RADIOLOGICAL AND CLINICAL ASSESSMENT

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AIM: Although loss of anterior teeth raises difficult therapeutic problems in young adulthood, the use of implants in growing patients has rarely been fully documented through prospective clinical studies. The aim of the investigation was to evaluate the impact of residual

growth in late adolescence on single implant-borne crown restorations in the anterior area.

SUBJECTS AND METHOD: Twenty-three unilateral implants in the antero-superior area of patients, aged 15.5 to 20 years, a minimum follow-up of 3 years after surgery. Available files included radiological examination immediately pre- and post-surgery, and 3 years after surgery. Clinical evaluation was documented before and after prosthetic rehabilitation with a minimum follow-up of 1 year after prosthodontics. Radiological evaluation was made after digitization of the radiographs, and measurements of vertical movements of adjacent teeth relative to the implant-bone structure were performed.

RESULTS AND CONCLUSION: Vertical movements of the adjacent teeth were observed in all patients even after cessation of their growth period (mean ≤ 1.0 mm). No correlation was noted between age at implant surgery and the amount of observed movement. There was no clinical significance due to delay between implantation and fixed prosthetics. The probability of undesirable vertical discrepancy between the position of the natural dentition and the osseointegrated implant even after the growth peak, although not significant because of limited residual growth, should be anticipated. However, as individual growth variations do not allow definition of reliable prognostic tools, it seems advisable to wait until the end of possible residual growth.

12 ECONOMIC EVALUATION OF ORTHOGNATHIC TREATMENT

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AIMS: To investigate outcomes of orthognathic treatment using the cost utility technique to calculate the cost per quality adjusted life year (QALY) gained.

SUBJECTS: Twenty-five patients undergoing orthodontics and orthognathic surgery.

METHODS: This was a longitudinal study in which orthognathic patients were interviewed five times during treatment (pre-treatment; twice during pre-surgical orthodontics, one month following surgery, and two months following debond). Total interview time for each patient was 2.5–3 hours. The utility value for the patient's current health state was determined using three standard methods: the Rating Scale, Standard Gamble, and Time Trade-off. The QALYs gained as a result of treatment were calculated by multiplying the change in utility value as a result of treatment by the remaining life expectancy of the individual [i.e. (utility value at T5-utility value at T1) \times future life expectancy]. QALYs lost as a result of the treatment process were calculated in a similar way and subtracted from this value to give the overall QALYs gained. The costs of treatment for each individual patient and the cost per QALY were calculated. All costs were subjected to sensitivity analyses and both costs and QALYs were discounted (at discount rates of 6 and 2 per cent, respectively).

RESULTS: QALYs gained varied between 8.13 and 14.02 (non-discounted) and 5.12 and 8.98 (discounted). Costs varied from a low estimate of £2550 for the single jaw group to a high estimate of £5507 for the bimaxillary group. The resultant cost per QALY gained varied between £206 and £1074 depending on the methodology used.

CONCLUSIONS: Orthognathic treatment is an intervention that provides good benefits at a relatively low cost. The cost utility technique is one that should be explored further in orthodontics.

13 THE ZYGOMA ANCHORAGE SYSTEM—AN ALTERNATIVE TO HEADGEAR

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AIMS: To develop a new implant to increase orthodontic anchorage in the posterior segment—the zygoma anchorage system (ZAS).

MATERIAL: The upper part of the anchor consisted of a titanium miniplate containing four holes, fixed by means of three or four titanium miniscrews to the zygomaticomaxillary buttress, above the roots of the molars. A wire was attached to the plate. A ball with a locking screw at the end of the wire made it possible to fix an auxiliary wire.

METHOD: Under local anaesthesia a vertical L-shaped incision was made mesial to the zygomatic crest. The plate was adapted to the curved shape of the crest and, after placement of the screws, it was covered by the flap. The wire passed through the attached gingiva in front of the first molar. One month after anchorage placement, a fixed appliance was bonded. Two to three months later, after orthodontic alignment, a closed nickel titanium spring of 50 or 100 grams was fixed to the anchor.

RESULTS: Twenty-one ZAS were placed in 13 patients. The surgical procedure took 20 minutes and was not traumatic for the patient. Some minor oedema around the implant may occur the day after surgery. Eighteen anchors were used to distalize the anterior teeth. Up to the present no anchor has been lost following force application. The anchors and the auxiliary system are well tolerated by the patients. After orthodontic treatment a small vertical incision had to be made under local anaesthesia to remove the miniscrews and the titanium plate.

CONCLUSION: The ZAS can be an alternative for conventional extra-oral anchorage to counteract the reaction forces from distal movement of anterior teeth, especially in adults.

14 LONG-TERM STABILITY OF LEVELLING OF THE CURVE OF SPEE

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AIMS: To investigate whether or not orthodontic levelling of the curve of Spee is a long-term treatment procedure with stable results. In a long-term retrospective study, the

change in the curve of Spee was assessed and correlated with the evolution of the irregularity index, the overjet, and the overbite.

MATERIAL: Measurements were made on the plaster casts of 149 orthodontically treated patients (57 males, 92 females). The mean age before treatment was 12.8 years, ranging between 8 and 25 years. Study casts were taken pre-treatment (T1), at the completion of orthodontic therapy (T2), and 6.7 years (mean) post-treatment (T3). The inclusion criteria were: no extractions carried out, all Angle classifications, except Class III malocclusions, and all permanent teeth fully erupted, except second and third molars.

METHODS: The curve of Spee and the irregularity index were measured on standardized digital photographs of the casts. The overjet and overbite were assessed with a ruler.

RESULTS: (1) Levelling of the curve of Spee was found to be stable. (2) The initial depth of the curve of Spee and the initial irregularity index were not related to any relapse. (3) The amount of levelling was not correlated with relapse of the curve of Spee, the irregularity index, the overjet, or overbite. (4) There was a mild correlation between relapse of the curve of Spee and relapse of the irregularity index, overjet, and overbite.

CONCLUSION: Levelling of the curve of Spee during orthodontic treatment seems to be very stable on a long-term basis and weakly correlated with the other tested variables.

15 GROWTH STIMULATION OF MANDIBULAR CONDYLES AND FEMORAL HEADS BY IGF-I *IN VITRO*

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AIMS: To compare *in vitro* the growth of the mandibular condyle of newborn rats with that of the femoral head and to analyse the effects of IGF-I on these two types of cartilage.

MATERIAL: Mandibular condyles and femoral heads from 4-day-old Wistar rats.

METHODS: The femoral heads and the mandibular condyles were dissected and cultured for up to 2 weeks with 0, 5, and 25 ng/ml IGF-I. Standardized slides were made three times per week to monitor growth. At regular intervals, samples were harvested to analyse glycosaminoglycan (GAG) and DNA synthesis, to determine GAG and hydroxyproline content, and for histology. Statistical analysis (two-way ANOVA) was performed.

RESULTS: Both 5 and 25 ng/ml IGF-I significantly stimulated the growth of the mandibular condyles. Growth of the condyles cultured with 25 ng/ml IGF-I was also significantly higher than that of the group cultured with 5 ng/ml IGF-I. Only 25 ng/ml IGF-I significantly stimulated growth of the femoral heads compared with the controls. There was a significant increase in DNA synthesis of mandibular condyles with 25 ng/ml IGF-I while that of femoral heads was not affected. Both 5 and 25 ng/ml IGF-I stimulated GAG synthesis of condylar and femoral cartilage. The GAG and hydroxyproline content of condylar and femoral cartilage slightly, but not significantly, increased

with the presence of IGF-I. Histological evaluation showed clear-cut differences between the two types of cartilage.

CONCLUSION: Secondary condylar cartilage and primary femoral cartilage are both stimulated by IGF-I; the effect is dose-dependent but is not similar for all parameters studied. The presence of 25 ng/ml IGF-I stimulated growth of mandibular condyles and femoral heads in culture.

16 ANALYSIS OF RELAPSE FOLLOWING RAPID CLASS II CORRECTION WITH EUREKA SPRINGS

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AIMS: To identify and quantitate the factors that contribute to an increase in overjet immediately following orthodontic correction of overjet utilizing Eureka springs (ES).

SUBJECTS: Twenty-eight individuals (mean age 12.8 years; 18 girls, 10 boys).

METHODS: From a sample of adolescent patients (85 females, 30 males) treated to complete overjet correction with bilateral Class II ES, 28 relapsed at least 2 mm within the following four months. Every four weeks the force was measured and adjusted such that 90–150 grams (0.88–1.47 N) were exerted during the correction interval. As soon as the overjet was corrected the ES were removed. Lateral cephalograms were obtained at completion of treatment and at observed relapse. Thirteen variables were used to determine the direction and magnitude of relapse.

RESULTS: At *P*-values of 0.001 or less the following changes occurred (mean values in parentheses). The maxillary central incisor moved anteriorly from the reference grid (1.5 mm), from the A–Po line (1.2 mm), increased its angle to the Sella–Nasion line (4.4 degrees) and intruded (0.7 mm). The mandibular central incisor moved distally from the reference grid (1.0 mm), the A–Po line (1.1 mm), decreased the angle with the mandibular plane (4.3 degrees) and extruded (0.8 mm). No significant changes occurred in maxillary and mandibular molars except for 1.0 mm of maxillary molar extrusion.

CONCLUSION: Significant overjet relapse occurred soon after correction in approximately 20 per cent of adolescent patients treated with Class II ES if the force of the springs was maintained throughout treatment at 90–150 grams.

17 CLINICAL AND COMPUTERIZED ASSESSMENT OF MANDIBULAR ASYMMETRY

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AIMS: To investigate the reliability of mandibular asymmetry assessment by clinicians and to validate a new computerized system of assessment.

METHODS: Four maxillofacial surgeons and four orthodontists assessed 12 standardized photographs of patients selected to provide a range, from normality to marked mandibular asymmetry. Photographs were taken under standardized conditions with controlled lighting. The assessments were repeated after two weeks. Computerized assessment involved the digitization of the mandibular outlines and subsequent use of four different methods of quantifying asymmetry, based on right/left differences in perimeter, area, compactness, and centre of area ratios. Repeatability of photography as well as digitization was assessed.

RESULTS: Intra-examiner agreement for the orthodontists was $\kappa=0.62$ (good agreement) and for the maxillofacial surgeons $\kappa=0.88$ (very good agreement). The four parameters were assessed for sensitivity and specificity in relation to the clinical assessment. Differences in perimeter ratios did not compare well with clinical assessment, but those for both area and compactness showed 100 per cent sensitivity and specificity to clinical assessment at ratio differences of 0.05 and 0.03 (deviation from 1), respectively. A centre of area difference ratio greater than 1 showed 75 per cent sensitivity and 85 per cent specificity to clinical assessment. Variation in photography and digitisation was within highly satisfactory levels.

CONCLUSIONS: Good agreement was obtained by the eight clinicians in assessing the anticipated need for treatment for mandibular asymmetry. Good agreement was also observed in the measurements when the assessments were made on repeated photographs. Compactness, area and, to a lesser extent, centre of area ratio differences, showed high sensitivity and specificity to the clinicians' assessment of treatment need. Thus the computer system may be of value in quantifying mandibular asymmetry.

18 A NEW TREATMENT MODALITY FOR CORRECTION OF ANTERIOR OPEN BITE —ZYGOMATIC ANCHORAGE

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AIMS: To evaluate the use of the zygomatic area as a site of anchorage for intrusion of maxillary posterior teeth.

SUBJECTS: Ten adult patients (6 females, 4 males) with an average age of 22.5 years, presenting a minimum anterior open bite of 2 mm and an occlusal plane–palatal plane angle < 4 degrees.

METHODS: A transpalatal arch, passing 3 mm from the palate, was soldered to the first molar bands. Brackets were placed on premolars and second molars on both sides. After levelling, 0.017 × 0.025-inch stainless steel wires were applied to both segments. In the surgical procedure, a horizontal incision at the sulcus depth and under the zygomatic area was performed. A mucoperiosteal flap was elevated and the zygomatic process of the maxilla was reached. One end of a titanium miniplate was fixed to the zygomatic process, while the other end was left free for force application. The flap was

sutured leaving the lower end of the miniplate exposed to the buccal sulcus. After removal of the sutures, heavy nickel titanium closed coil springs were applied between the exposed end of the miniplate and the first molar tooth, exerting 300 g of force per side. The force level of the coil springs was checked and adjustments were made at monthly visits. Treatment effects were evaluated on lateral and postero-anterior cephalograms and study casts.

RESULTS: In two patients the plates were removed due to developing local infection. In the remaining patients, a mean intrusion of 3.5 mm and buccal tipping of 7 degrees were measured at the first molars after an average force application period of four months. In these subjects a remarkable decrease in open bite was observed clinically.

CONCLUSION: The zygomatic area was found to be a useful anchorage site for intrusion of posterior teeth. This procedure needs to be modified for patient comfort and improved oral hygiene.

19 CRANIOFACIAL GROWTH CHANGES IN FINNS: A CEPHALOMETRIC TEMPLATE METHOD

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AIMS: To present, by facial templates, longitudinal craniofacial growth in Finnish boys and girls, and to show the effect of using different reference planes.

SUBJECTS: In the Helsinki longitudinal growth study 50 boys and 55 girls were examined from 4 to 25 years of age by taking lateral cephalograms and digitizing the cranial and facial measurements by computer. Altogether 551 roentgenograms were obtained, 3–8 pictures of each child.

METHOD: Forty-four templates, 22 for males and 22 for females, were created according to the cephalometric mean values. The Sella–Nasion reference line and the anatomic cranial base were used to superimpose the templates at different ages to study the growth patterns of males and females, and at the same age to reveal differences in their facial form.

RESULTS: A considerable amount of growth could be demonstrated between 16 and 21 years of age, especially in boys. There was a closing growth pattern in both genders, more pronounced in boys and more so in the later age periods. In boys the facial dimensions were larger and the facial geometry was more closing than in girls. This sexual dimorphism increased after 11 years of age. The chosen reference plane may influence the impression of the facial pattern.

20 TORSIONAL PROPERTIES OF NiTiCu ORTHODONTIC ARCHWIRES—THE EFFECT OF TIME

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AIMS: Commercially preformed NiTiCu archwires are used in orthodontics to move teeth with low forces and slow

deactivation. The mechanical properties vary with their crystallographic phases, which are linked to temperature and the amount of stress. The aim of this study was to determine whether these properties are also conditioned by time.

MATERIAL AND METHODS: Commercial NiTiCu single thread 0.017×0.025 -inch (0.435×0.64 mm) orthodontic archwires were tested. The mechanical characteristics were studied with a torsion apparatus specially designed to simulate clinical conditions. The stress/strain behaviour of eight archwires drawn from the same commercial batch was examined in induced torsion under controlled conditions of moment and temperature for different periods of times (1 and 24 hours, and 20 and 30 days).

RESULTS: On the test-diagram, the plateau region of the superelastic effect appeared at around 40 degrees of torsion. Such high degrees of torsion rarely occur under normal clinical use. Moreover when an orthodontist uses the plateau of the superelastic effect, the residual deformation after unloading varies from 40 to 0 degrees of torsion and is independent of the length of time it is kept under stress. Variation of behaviour from one arch to the other within the same batch is such that it becomes impossible to foresee the magnitude of forces delivered clinically.

CONCLUSION: It clearly appears that in most cases orthodontists use the low stiffness of the austenitic phase of the NiTiCu alloys and not the superelastic effect. Such low stiffness can probably be obtained just as well using multibraid stainless steel wires, with the added advantage that they can better be shaped to fit the patient's own dental arch form.

21 BRACKET BONDING WITH SELF-ETCHING PRIMERS

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AIM: To evaluate *in vitro* the bonding capacity of self-etching primers.

MATERIAL: Three self-etching primers were evaluated: Clearfil SE Bond [(SE), Kuraray], Clearfil Liner Bond 2V [(CLB), Kuraray], and Novabond [(NOVA), Bonadent]. Two adhesive systems with a separate phosphoric acid etching procedure, Gluma Comfort Bond [(GLU), Heraeus Kulzer] and Kurasper F [(KU), Kuraray], served as controls. **METHOD:** Sixty human incisors were embedded in epoxy resin. The buccal surfaces were ground flat on wet SiC papers and the adhesives were applied following the manufacturers' instructions. Additionally, NOVA was applied in a simplified bonding procedure (NOVA 2). Metal brackets, Mini Mono (Forestadent, base: 9.6 mm²), were bonded with the corresponding bracket adhesive. For each material, 10 specimens were prepared and stored in deionized water (37°C) for 24 hours. The bonded brackets were loaded until failure using a Zwick universal testing machine. The shear bond strength (SBS) data were subjected to one-way ANOVA (significance level: 0.05 per cent).

RESULTS: Mean SBSs in MPa were calculated: SE 9.4 ± 2.2 , CLB 11.3 ± 2.6 , NOVA 19.6 ± 3.6 , NOVA 2 9.0 ± 4.8 ,

GLU 10.6 ± 3.5 , KU 10.8 ± 2.9 . No significant differences were found between the groups ($P > 0.05$).

CONCLUSION: Bracket bonding with self-etching primers is as effective as conventional bonding to acid-etched enamel.

22 BIMAXILLARY ORTHOGNATHIC SURGERY WITH CONCOMITANT GENIOPLASTY TO CORRECT OROFACIAL DEFORMITIES

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AIM: To evaluate the relationship between hard tissue surgery and the effect on the overlying soft tissue. This predicts final facial proportions and profile, and determines the amount of genioplasty movement needed in all three dimensions for optimal chin aesthetics.

SUBJECTS AND METHOD: Twenty-one patients (13 females, 8 males) with a mean age of 25.2 years, treated by bimaxillary surgery with concomitant genioplasty. A Le Fort I osteotomy and bilateral sagittal split ramus osteotomy and osteotomies of the inferior border of the mandible for sagittal augmentation and reduction, vertical augmentation and reduction, transverse correction of the chin were performed.

RESULTS: Following the Milan school protocol of data collection, model surgery, clinical and cephalometric evaluation, treatment planning in a three-dimensional key, these surgical procedures enhanced the middle and lower third facial balances, both anteriorly and in profile, normalized the lower third of the face's vertical and sagittal aesthetic relationships, and softened the face. Sliding set back, asymmetric, and grafted genioplasties are less predictable than advancement genioplasty. In fact soft tissue changes are more variable than those with mandibular advancement.

CONCLUSION: Genioplasty is a useful versatile adjunctive surgical procedure to achieve aesthetic and functional results with the goal of overall facial harmony and balance.

23 THE EFFECT OF TOOTH POSITION ON THE IMAGE OF UNERUPTED CANINES ON CEPHALOGRAMS

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AIM: To evaluate whether panoramic tomograms and cephalograms, which are commonly used in orthodontic practice, can provide adequate information on the localization of an impacted canine. In a previous study, the radiographic image of impacted canines on dental panoramic radiographs (DPT) was investigated. In this study, the effect of changes in position and inclination of

the impacted canine on cephalograms was investigated in an experimental set-up.

MATERIAL AND METHODS: An upper canine was removed from a human skull and replaced in a system, able to imitate position variations of impaction. Starting from the buccally impacted position, three different displacements were simulated, 10 mm in a frontal, 10 mm in a sagittal, and 5 mm in a vertical direction. In each of these positions nine different changes in inclination were registered, resulting in 36 different cephalographic and tomographic exposures. All information was visualized in diagrams in an attempt to identify relationships between the different variables (positions).

RESULTS: Analysis of the cephalograms revealed the following: the degree of vertical and sagittal displacement of the incisal point of the impacted canines, the angulation of the tooth, as well as tooth length, measured on a cephalogram, appeared to give a realistic expression of the experimental situation. A diagram was constructed enabling the exact inclination in the frontal plane of an impacted tooth to be determined by combining its angulation to the occlusal plane on both radiographic exposures.

CONCLUSION: Combining these findings and those from the DPT study, it became possible to make a checklist enabling a more adequate three-dimensional estimation of the canine's position. A palatally impacted canine was chosen as a clinical illustration of this experimental set-up.

24 TORQUE CAPACITY OF ORTHODONTIC POLYCARBONATE BRACKETS

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AIM: Clinical simulation of force transformation of the slots, as well as the equivalent torque capacity of synthetic brackets in comparison with a metal bracket.

MATERIAL: Four types of orthodontic polycarbonate brackets were tested and compared with steel brackets. The polycarbonate brackets underwent multiple immersion cycles in a saliva suspension.

METHODS: 1. *In vitro* torque experiments to measure reaction to expansion as well as resistance to mechanical strain of the brackets beyond the arch of the teeth were compared. 2. A further investigation with the Orthodontic Measurement and Simulation System [(OMSS), Bouraul *et al.*, 1992] of the frontal crown torque of an upper central incisor within the arch of teeth was carried out to simulate the clinical situation. The brackets were torqued with 0.016×0.022 -inch and 0.018×0.022 -inch steel wires.

RESULTS: The polycarbonate brackets showed, in both experimental procedures with the two steel arches, a significantly higher torque loss and lower force application compared with the metal brackets. The required force for root movement was achieved with a torque angle between 8 and 20 degrees. During the simulation experiments the metal

brackets once again reached a significantly higher torque moment compared with the synthetic brackets. However in clinical simulation with OMSS the torque loss was significantly higher than during the *in vitro* reaction experiments. The reason for that is the buffer effect of adjacent teeth with an extra space for the edgewise arch. Additionally there is the possible appearance of vertical and horizontal subsidiary forces while winding the edgewise arch.

CONCLUSION: With the knowledge of the high torque loss, the torque conditioning displayed in the straightwire technique must be questioned. Further information is required from the manufacturers concerning distortion of the polycarbonate brackets, which has to be compensated by additional torque.

25 GROWTH MODIFICATION OF SEVERE SKELETAL CLASS II MALOCCLUSIONS BY DENTOFACIAL ORTHOPAEDICS

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AIM: To determine the amount of growth modification during initial and late stages of treatment, and the initial phase of retention of skeletal Class II malocclusions.

SUBJECTS: Twenty-two consecutive patients (12.6 ± 1.4 years) with skeletal Class II malocclusions having active treatment with headgear-Herbst followed by 'active retention' with a headgear activator. The matched controls comprised 31 subjects.

METHODS: Cephalograms were obtained at the start of treatment (T1), after 6 months (T2), at 12 months (T3) (end of treatment/start of retention), and at 18 months (T4). Analysis was carried out according to Pancherz.

RESULTS: Total effect (T4-T1) on apical base relationship was 5.4 mm ($P < 0.001$) due to restraint of the maxilla (-3.0 mm; $P < 0.001$) and increased mandibular growth (2.4 mm; $P < 0.001$). There was no statistical difference in initial effect (2.8 mm; $P < 0.05$) versus late effect (2.2 mm; $P < 0.01$) on apical base relationship. During 'active retention' there was no significant effect (0.4 mm; n.s.). The effect on the maxilla was significant during both phases of treatment, being larger during the late phase. For the mandible the reverse pattern was seen, the effect being larger during the initial phase. During retention there was an insignificant (0.4 mm; n.s.) improvement of apical base relationship. LFH and mandibular plane angle were not affected during the initial phase, but were significantly reduced during the later phase of treatment and retention. Total effect on LFH was restraint (-2.7 mm; $P < 0.001$) and the mandibular plane angle closed (-1.1; $P < 0.001$).

CONCLUSION: There are significant effects on the sagittal and vertical dimensions by growth modification with an orthopaedic functional appliance. The pattern of skeletal effects in the sagittal and vertical dimension differs between the initial and late phases of treatment. The effects are maintained/enforced during the retention period.

26 NATURAL HEAD POSITION AND THE PERCEPTION OF FACIAL MORPHOLOGY

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AIM: To assess the validity of two main concepts underlying the use of natural head position (NHP) in orthodontic diagnosis, namely: (A) that head position should be adjusted by the orthodontist if it seems unnatural, and (B) that perceived facial morphology depends on head position.

METHOD (A): Lateral photographs of 14 patients were used. Each was warped to produce two new images, with the chin positioned backwards or forwards relative to the original (± 2 degrees change of the soft-tissue N-Pg line). All 42 images were placed in circular frames and shown to six orthodontists, who were asked to orientate them to the estimated NHP. Image orientation between the three chin positions was measured and compared.

RESULTS: Estimated NHP depended on chin position. Images with protrusive chins were positioned with the head rotated more downwards [Frankfort plane (FH) at 2.33 degrees relative to horizontal] than images with retrusive chins (FH at 4.14 degrees). The difference in head orientation measurements was half of the difference in chin position (1.81 degrees for a chin change of 4 degrees).

CONCLUSION: The validity of the aesthetic or estimated NHP for diagnosis is questioned, since it depends on the same factor it aims to assess.

METHOD (B): A single photograph was warped to produce 30 frames depicting a gradual change from a posterior to an anterior chin position. Using computer software, these frames could be displayed sequentially, giving the impression that the chin was moving forwards or backwards. Adjacent to this user-adjustable image, one of the intermediary frames was displayed, as a reference image, either in the same orientation or rotated (extended or flexed by 10 degrees). Thirty laypersons used the keyboard and moved the chin until the face seemed to them identical to the reference image. The selected image frame was noted.

RESULTS: Judges could estimate facial morphology without systematic error when the head was horizontal or rotated downwards. However, when the reference image was rotated upwards, chin protrusion was overestimated.

CONCLUSION: Perception of facial profile form may be different when the head is extended than when it is flexed or in a horizontal position.

27 THE INFLUENCE OF LATERAL HEAD RADIOGRAPHS IN ORTHODONTIC DIAGNOSIS AND TREATMENT PLANNING

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AIM: Lateral head radiographs are used as a diagnostic tool for most orthodontic patients. However, in clinical practice the diagnosis and preliminary treatment plan is often set at

the first clinical examination. The purpose of this study was to evaluate the influence of lateral head radiographs in orthodontic diagnosis and treatment planning.

MATERIAL AND METHODS: Forty orthodontists were randomly selected from a list of 290 active members of the Swedish Orthodontic Society. Thirty-five of the orthodontists answered the questionnaire and performed the analysis. The material consisted of six cases with an obvious orthodontic treatment need. The case-material consisted of questionnaires, duplicates of study casts, extra-oral photographs, and lateral head radiographs. The case material was sent in two packages on two different occasions. The first package included a questionnaire, study casts, and extra-oral photographs. Thus, the orthodontists were asked to state the diagnosis, treatment plan and prognosis for treatment without access to lateral head radiographs. When this questionnaire was returned, a new package was sent containing copies of the lateral head radiographs of the six cases, a copy of the completed questionnaire, a new questionnaire similar to the previous, and an additional questionnaire with general questions about the importance of lateral head radiographs and cephalometric analysis.

RESULTS: The additional information from the lateral head radiographs and the cephalometric analysis changed the diagnoses substantially in only 1 per cent of the cases. The treatment plan was significantly changed in 6 per cent and the prognosis was altered markedly in 3 per cent of the cases. Remarkably enough the orthodontists judged the lateral head radiographs to be important in the decision-making in 81 per cent of the cases.

CONCLUSION: Lateral head radiographs seem to be less important in clinical decision-making in most cases, although orthodontists believe them to be of utmost importance.

28 BIOMECHANICAL PRINCIPLES AND ORTHODONTICS

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KEYNOTE ADDRESS

The cascade of biological events that produce movement of teeth results from a signal sent by a force system. In orthodontics the appliance sends the signal by exerting a physical force on the tooth that displaces the tooth. The displacement of the tooth somehow provokes the surrounding biological structures to enter into a myriad of often, diverse cellular and biomechanical responses in what we know as tooth movement.

It is known that the responses that occur involve diverse tissue reactions. Areas of bone resorption exist adjacent to areas of bone deposition. How can tooth displacement provoke both of these processes side by side? A three-dimensional image of the tooth makes it obvious that tooth displacement must result in a spectrum of different stimuli to the biological environment.

Presumably different biological reactions require different signals. Since tooth movement is provoked by physical

displacement of the tooth, it is logical to expect that the different biological responses that occur are the result of differences in tooth displacement.

While the bio portion of biomechanics is based on the biological sciences, the biological mechanisms are not well understood. The mechanical portion of biomechanics is based in physical sciences and this is well documented. The physical actions of archwire forces are relatively controllable and, since they provoke the biological responses, they are fundamental to a comprehensive understanding of biomechanics and tooth movement.

This presentation will identify the finite types of physical displacements possible with archwire mechanics. This will raise issues of how the biological systems read and sort out these signals to result in tooth movement. Biomechanics can do much toward controlling force systems, but often these well-understood physical sciences laws are not used as a basis for appliance design. Once the physical principles governing appliance actions are understood, these principles can be routinely applied for the efficient application of force systems to teeth.

29 RAPID CANINE RETRACTION USING DENTOALVEOLAR DISTRACTION OSTEOGENESIS

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AIM: To report the effects of rapid movement of maxillary and mandibular canines by the dentoalveolar distraction (DAD) technique.

MATERIAL AND METHOD: Twenty maxillary and mandibular canines of 12 growing or adult subjects (6 females, 6 males). The initial mean age was 16 years, with a range of 13 to 25 years. A custom-made, intra-oral rigid tooth-borne distraction device was inserted after a minor surgical procedure, and activated twice a day, once in the morning and once in the evening.

RESULTS: The canines moved into the cavity of the extracted first premolars, in compliance with distraction osteogenesis principles. Distraction procedure was completed in 10–15 days at a rate of 0.8 mm/day. Full retraction of the canines was achieved and the anchorage teeth (first molars and second premolars) were able to withstand the retraction forces with no anchorage loss. The distal displacements of the canines were mainly a combination of tipping and translation ($P < 0.01$). No clinical or radiographic evidence of complications such as root fracture, root resorption, ankylosis or soft tissue dehiscence were observed. However, increased pocket depths were detected for the retracted canines at the end of the distraction period. The patients demonstrated minimal to moderate discomfort especially during the first two days following surgery, and oedema was observed in some of the patients. Minimal or no discomfort was reported during activation of the device.

CONCLUSION: Full retraction of the canines could be achieved in 10–15 days, without the need for extra- or

intra-oral anchorage devices. The DAD technique is an innovative method, especially in adult cases, since it reduces the overall orthodontic treatment time by nearly 50 per cent, with no unfavourable effects on surrounding structures.

30 LONG-TERM SUCCESS OF BIONATOR THERAPY ASSESSED BY MODEL ANALYSIS AND THE PEER ASSESSMENT RATING INDEX

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AIM: To assess the long-term stability of orthodontic treatment achieved with a functional bionator appliance in a 20-year follow-up study.

MATERIAL: Dental casts of 36 patients who originally had an Angle Class II malocclusion were analysed. The same practitioner had treated all patients with a functional bionator appliance 20 years previously. Dental casts were taken at four stages for each patient: T1 = pre-treatment, T2 = end of bionator therapy, T3 = end of orthodontic treatment, and T4 = 20 years after bionator therapy.

METHODS: Model analysis was performed both manually and with the help of a computer-aided program. The parameters measured were: overjet, overbite, anterior alignment, anterior and posterior arch width, and arch length. The dental casts were also evaluated for the long-term outcome using the standardized Peer Assessment Rating (PAR) Index.

RESULTS: To a considerable degree, the dentoalveolar adaptation achieved by bionator therapy remained stable. The change in overjet was maintained 20 years post-retention, whereas the overbite increased significantly during the post-treatment interval. Anterior crowding increased in both the upper and lower arches. Arch width remained stable in the upper arch, but decreased in the lower. Arch length diminished in both jaws. In 52.8 per cent of the patients there was an improvement of their dental malocclusion (measured by PAR Index) by at least 30 per cent compared with the initial findings. Of these improved cases, 16.7 per cent even showed a greatly improved PAR score 20 years after treatment. The remaining 47.2 per cent did not exhibit improvement.

CONCLUSION: Both the model analysis and the PAR score show an altogether positive long-term outcome of bionator therapy 20 years after treatment.

31 FUNCTIONAL INFLUENCE ON SUTURAL BONE APPPOSITION IN THE GROWING RAT

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AIM: To quantify sutural bone apposition in the various parts of the rat's upper frontal viscerocranium and study the

possible effects caused by reduced masticatory muscle function.

MATERIAL AND METHODS: Twenty-six growing male albino rats were randomly divided into two equal groups; one group (Hard Diet group; HDG) received an ordinary diet in a hard pellet form, while the other (Soft Diet group; SDG) a soft diet. The experimental period started just before the rats' pubertal growth spurt (28 days of age) and its duration was 42 days. At the beginning and in the middle of the experimental period calcein was injected in all animals. After sacrifice, the heads of the animals were taken for preparation of undecalcified frontal sections, 120 µm thick. Three representative homologous sections, for every animal in both groups, were selected and studied under a fluorescence microscope. The level of bone apposition at the time of the calcein injection was marked with separate fluorescing lines. The bone apposition rate in the internasal, naso- and inter-premaxillary sutures was quantified using an automatic image analysis system.

RESULTS: In both groups greater bone apposition was found during the first half of the experimental period. The bone apposition rate was smaller in the SDG than in the HDG in all sutures studied ($P < 0.001$). Especially in the nasopremaxillary suture bone, apposition during the total experimental period was 25 per cent less in the SDG than in the HDG.

CONCLUSIONS: Bone apposition rate in the facial sutures is significantly affected by reduced masticatory function. This may be one of the mechanisms responsible for the regulation of facial growth.

32 JUDGEMENT OF FACIAL AESTHETICS BY ADULT LAYMEN FROM BELGIUM AND THE NETHERLANDS

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AIM: To determine the opinion of different panels on facial aesthetics in orthodontic Caucasian patients.

MATERIAL: Pre-treatment photographic views (frontal, three-quarter smiling, and lateral) of 64 healthy Caucasian orthodontic patients, aged 10 to 16 years, were randomly selected with the stratification of having 7–9 boys and 7–9 girls for each of the four Angle Classes.

METHOD: A panel of 12 male and 24 female adult Belgian laymen (mean age = 48.3 years) and a panel of 26 male and 16 female adult laymen from The Netherlands (mean age = 53.2 years) were asked to rate the photographic views on a visual analogue scale from 0 to 100, in relation to a previous selected reference photographic view (1 boy, 1 girl). Duplicate photographic views of 10 per cent of the patients were added to the series.

RESULTS: The reliability of the measurements was good for the whole group (Cronbach's $\alpha = 0.98$). The median individual random error was 6.8 ($P_{25} = 4.7$; $P_{75} = 10.5$). The median individual reliability was 0.68 ($P_{25} = 0.44$;

P75 = 0.81). There was a significant difference in the opinion of the panels from the different countries. The Belgian panel was more critical in judging the photographic views of females. There was no significant influence of the gender of the judges. The age of the judges was positively correlated with the aesthetic score on the photographs of the males.

CONCLUSION: Judgement of facial aesthetics by laymen is possible, but there are regional differences in opinion.

33 PRENATAL RESORPTION ACTIVITY DURING EARLY BONE REMODELLING OF THE HUMAN MANDIBLE

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AIM: Computer-supported reconstructions and statistical investigation of the resorption activity during the early bone remodelling process of the human mandible during prenatal development.

MATERIAL: Histological serial sections of seven human embryos and foetuses ranging from 22 to 117 mm crown-rump-length (CRL).

METHODS: The bony contours of the mandible were analysed and traced under a Zeiss light microscope with an integrated drawing mirror at magnifications ranging between $\times 25$ and $\times 40$. The differentiation of osteoclasts occurred at magnifications between $\times 100$ and $\times 400$, regarding morphological and staining-specific criteria. The resorptive bone surfaces characterized by large, polynucleate osteoclasts were marked with a specific colour at the bony outline of the histological drawings. Using a graphic tablet, these data were entered into a three-dimensional reconstruction computer program and visualized.

RESULTS: The first signs of bone resorption were identified at the stage of 41 mm at the posterior part of the mandibular ramus. Resorption around the tooth buds was observed at the stage of 53 mm CRL. Beginning with the stage of 53 mm CRL up to the continuous series, a close relationship between localization and the course of the alveolar inferior nerve could be recognized. The occurrence of connected resorptive fields started at the stage of 53 mm CRL. At this early stage up to the stage of 117 mm CRL, a concentration of resorptive fields at the anterior edge of the mandibular ramus could be shown. Statistical evaluation of cell distribution showed different amounts ranging from 1 per cent resorption activity at the stage of 41 mm CRL, up to 16.5 per cent at the stage of 68 mm CRL.

34 'IT WORKS IN MY HANDS'

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KEYNOTE ADDRESS

Disturbances in occlusal development lead to orthodontic malocclusions. Interceptive orthodontics, as well

as orthopaedic treatment, will help to correct and guide disturbances in occlusal development. A thorough understanding of the aetiology, diagnosis, orthodontic treatment planning, and prognosis is a *sine qua non* for optimal orthodontic care. However, although evidence-based medicine and dentistry have been established for more than a decade, clinicians still tend to base their treatment decisions often on the 'it works in my hands' evidence provided by their peers.

Evidence-based dentistry has been described as 'the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients'—but where is such evidence to be found? The randomized controlled clinical trial (RCT) is considered to be the gold standard in research. A recent study revealed that over a 30-year period (1969–1999) only 41 RCTs on the above-mentioned orthodontic topics could be identified on MEDLINE, while more than 35,000 articles on these topics were published during that period!

Nowadays there is an increasing awareness in the medical and dental fields that the scientific soundness of many clinical studies is questionable. It has been proven that uncontrolled clinical studies tend to overestimate the effectiveness of a certain therapy while the established effectiveness drops dramatically when the same therapy is subjected to randomization.

In this lecture the results of some RCTs performed at the University of Nijmegen (The Netherlands) and elsewhere will be presented to illustrate the importance of evidence-based orthodontics for the clinician.

35 TOOTH ERUPTION PROBLEMS

J Kurol, Department of Orthodontics, Malmö University, Sweden

SHELDON FRIEL MEMORIAL LECTURE

During the mixed dentition period and shedding of deciduous teeth, disharmonies in permanent tooth eruption are common. Teeth may erupt out of their normal path of eruption, ectopic eruption. The most common and severe clinical problems are associated with the eruption of maxillary first molars and especially maxillary canines. The deflection of the canine path of eruption mostly causes a palatal medial path of eruption with a risk of more or less severe resorption of the roots of the permanent incisors. During shedding of the deciduous molars the presence of ankylosis, i.e. bony union between the root and alveolar bone may also hinder or deflect the path of eruption of the permanent successor and cause severe occlusal disturbances.

Several clinical considerations may be discussed before choosing a treatment strategy. The appropriate timing of diagnosis and various diagnostic procedures, including computer tomography, are important. Diagnosis is the basis when deciding to intercept in the child's growth of the jaws and development of the occlusion.

36 REVASCULARISATION AFTER CRYOPRESERVATION AND AUTOTRANSPLANTATION OF IMMATURE AND MATURE APICOECTOMIZED TEETH

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AIM: To measure the amount of revascularization after cryopreservation and autotransplantation of immature and mature apicoectomized teeth after removal of the original pulp tissue.

MATERIAL AND METHOD: Sixteen single-rooted teeth from two pure-bred dogs, 4 months and 7 days old. The root development was complete in 12 teeth, whereas four teeth had an open apex at the time of the experiment. After extraction, an apicoectomy was carried out on the 12 mature teeth. From every experimental tooth the pulp tissue was removed from the apical side at the moment of extraction with a nerve-broach. Eight teeth were stored at the tooth bank (-196°C) for 7 days before transplantation. The other eight were immediately transplanted. Micro-angiography was carried out after an observation period of 18 and 40 days for teeth with an open apex and after 10, 18, 33, and 40 days for the apicoectomized teeth.

RESULTS: Micro-angiography showed good revascularization in 11 of the 16 teeth. One tooth was lost and four showed poor revascularization.

CONCLUSION: There is no difference in revascularization between immature and mature apicoectomized teeth after removal of the original pulp tissue or between cryopreserved and immediately transplanted teeth. Twelve of the 16 teeth showed good to very good revascularization whereas four (25 per cent) showed, for unknown reasons, no or very poor revascularization.

37 A CLINICAL-TOMOGRAPHIC EVALUATION OF PATIENTS WITH JUVENILE RHEUMATOID ARTHRITIS

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AIM: To determine the incidence and type of temporomandibular joint (TMJ) involvement in patients affected by juvenile rheumatoid arthritis (JRA), and to compare the obtained data with a control group (CG).

SUBJECTS: Eighty-seven affected patients (26 males, 61 females), with an age range of 10 to 25 years, were compared with an age- and sex-matched CG of 69 healthy subjects.

METHODS: All subjects were tested using Helkimo's protocol (assessment of anamnestic, clinical dysfunction, and occlusal indices). A radiographic study was then undertaken using ipocycloidal tomograms. The tomographic features were evaluated according to Rohlin-Petersson's scale (grades 0-5 according to the severity of erosive changes).

RESULTS: The tomographic study showed arthritic-degenerative involvement in 93 per cent of patients, and in 33 per cent the grade was 4-5. Compared with the CG, the JRA subjects had a higher incidence of structural alterations such as skeletal Class II malocclusions (35 per cent JRA; 19 per cent CG), open bite (6 per cent JRA; 1 per cent CG), or asymmetries of the inferior third (63 per cent JRA; 3 per cent CG). No correlation was found between clinical dysfunction signs and morphological alterations on the TMJ tomogram. The severity of dysfunctional signs was dramatically lower than signs of severe morphological alterations of the TMJs.

CONCLUSIONS: These results confirm the importance of the TMJ involvement in patients affected by JRA. They confirm the necessity for periodic clinical and tomographic examinations, even in asymptomatic subjects.

38 TRANSVERSE DENTAL ARCH DIMENSIONS IN NINE-YEAR-OLD CHILDREN BORN IN THE 1960s AND 1980s

R Lindsten, Department of Orthodontics, The Institute for Postgraduate Dental Education, Jönköping, Sweden

AIM: To evaluate the transverse dental arch dimensions in the mixed dentition in children born in the 1960s compared with children born in the 1980s.

SUBJECTS: Nine-year-old children from Norway born in the 1960s, 30 girls and 31 boys, and nine-year-old children born in the same area in the 1980s, 26 girls and 32 boys. In Sweden, a group of nine-year-old children born in the 1960s, 35 girls and 31 boys, and a group of nine-year-old children born in the corresponding area in the 1980s, 37 girls and 30 boys were studied.

METHODS: The transverse distance between the left and right first permanent molars was measured. The minimal intermolar distance at the gingival margin, the intermolar distance between the mesiobuccal cusp tips, and the maxillary intermolar distance between the central fossae were used. The distance between the deciduous canines was also measured. The difference between the maxillary and the mandibular intermolar distances was calculated. The arch depth was measured from a line perpendicular to the first permanent molars to the incisors.

RESULTS: The difference between the maxillary and mandibular intermolar widths was smaller for the Norwegian and Swedish boys born in the 1980s compared with the groups born in the 1960s. The groups of girls did not differ from each other. After correction for the larger mesial drift in the 1960s groups, due to caries, this effect could also be seen in the girls. This was more obvious in the Swedish than in the Norwegian girls.

CONCLUSION: A trend toward a decrease in the difference between the maxillary and mandibular intermolar distances in children born in the 1960s compared with children born in the 1980s has been found.

39 DENTOALVEOLAR, OCCLUSAL AND SKELETAL CHANGES INDUCED BY FUNCTIONAL THERAPY

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AIM: To reveal dentoalveolar, occlusal, and skeletal changes in patients undergoing functional therapy with bite jumping appliances.

SUBJECTS: Sixty-nine patients with a dentoalveolar and skeletal Angle Class II division 1 malocclusion treated with bite jumping appliances between 10 and 14 years of age.

METHODS: The patients were divided into two groups: treatment initiation in the early and late transitory dentition. A cast analysis was used for evaluation of dentoalveolar (anterior arch length, and anterior and posterior arch width) and occlusal changes (overjet, overbite). Cephalograms were analysed to determine sagittal skeletal alterations (SNA, SNB, ANB) and changes in incisor position (Ils/NL, Ili/ML). Paired and unpaired *t*-tests were performed.

RESULTS: Treatment initiation in the early mixed dentition led to a significant increase ($P < 0.01$) in lower arch length; the other group revealed no changes. Other parameters underwent the same changes in both groups: upper and lower anterior and posterior arch width were increased ($P < 0.001$), in the upper more than in the lower arch. Overjet ($P < 0.001$) and overbite ($P < 0.01$) were decreased. SNA was reduced ($P < 0.001$) and SNB enlarged ($P < 0.01$), resulting in a reduction of ANB ($P < 0.001$). Treatment commenced in the early mixed dentition had a greater influence on upper incisor retrusion ($P < 0.01$ versus n.s.) and lower incisor protrusion ($P < 0.01$ versus n.s.) compared with the late mixed dentition group. Comparison of the results in both groups showed no significant differences in the final results for all evaluated parameters.

CONCLUSION: Functional orthodontic treatment with bite jumping appliances leads to dentoalveolar, occlusal, and skeletal changes towards an Angle Class I. The changes of incisor inclination and growth restriction of the maxilla lead to sufficient results in all cases.

40 REAPPRAISAL OF CLASS II MOLAR RELATIONSHIPS DIAGNOSED FROM THE LINGUAL ASPECT

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AIM: To evaluate the consistency of Class II molar relationships when assessed from the buccal and lingual sides, and the relationship with molar rotation and canine relationship.

SUBJECTS: Four hundred and fifty-nine clinically diagnosed Class II patients.

METHODS: Buccal molar and canine relationships were determined according to Angle's classification, whereas lingual molar relationships and molar rotation were assessed by visual appraisal.

RESULTS: Of the 459 Class II cases, 99 (10.49 per cent) sides exhibited a unilateral buccal Class I molar relationship

lingually and no molar rotation. One hundred and seventy-five (19.06 per cent) sides with a mild Class II buccal relationship showed a lingual neutral molar relationship and molar rotation in 85 per cent of the cases. In moderate Class II conditions, 55 per cent of the lingual relationships were Class I whereas 45 per cent belonged to mild Class II lingually with molar rotation appearing in 81 per cent of the cases. When a severe Class II tendency was found on the buccal side, its corresponding lingual Class II tendencies were accordingly elevated with a slight reduction of molar rotations (74 per cent). A Chi-squared test showed that the difference between buccal and lingual molar relationships and the correlation with the upper first molar rotation were all significant ($P < 0.001$). Canine relationship was linearly correlated with buccal molar relationship expressed as $Y_{\text{canine relation}} = 1.423 + 0.47 X_{\text{molar relation}}$.

CONCLUSION: Buccal molar relationships are not consistent with their corresponding lingual relationship in 90 per cent of conventionally diagnosed Class II cases: molar rotation commonly exists. Differential diagnosis of the molar relationships may help recognition of the true nature of malocclusion, on which correct and sound treatment plans should be based.

41 VISUALIZATION OF CRANIOFACIAL GROWTH AND ORTHODONTIC TREATMENT EFFECTS

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AIM: Presentation of an approach based on Euclidean distances between cephalometric landmarks to visualize and localize the shape changes of the complex craniofacial skeleton during growth and orthodontic treatment.

SUBJECTS AND METHODS: Individual growth-related craniofacial changes were investigated for a male orthodontically untreated subject from the Belfast Growth Study on the basis of lateral cephalograms at 7, 9, 11, 13, and 15 years. In addition, craniofacial shape changes were visualized for a group of 20 subjects treated with a modified Andresen-Häupl type activator and an orthodontically untreated control group from the Belfast Growth Study ($n = 15$). The inter-landmark distances between seven skeletal landmarks served as the database for the study. A modified Karhunen-Loève decomposition, based on orthogonal modes and time-dependent scalar amplitudes, was used to describe the growth process and the treatment-induced changes. The shape changes of the various craniofacial regions were visualized by allocation of colours to the respective distances, and overdrawn representations were reconstructed by means of multi-dimensional scaling.

RESULTS AND CONCLUSIONS: This visualization technique allows anatomical regions to be characterized with respect to reduced or increased growth compared with pure size changes. The clinically relevant mechanisms of craniofacial changes are visualized, e.g. shifts in the antero-posterior or vertical dimensions of the jaws. In addition, overdrawing the effects of shape change on the skeletal

structures gives a more readily comprehensible impression of the growth process. Taking account of the methodical limitations of this approach, e.g. the restrictions concerning the number of landmarks, the clinician may take advantage of this technique in orthodontic diagnostics in order to gain additional insight into the complex dynamic size and shape changes during development and treatment.

42 EFFECT OF A CHANGING FORCE MAGNITUDE ON THE RATE OF ORTHODONTIC TOOTH MOVEMENT

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AIM: To analyse the effect of altering force magnitude on the rate of orthodontic tooth movement in beagle dogs.

MATERIAL: Ten young adult beagle dogs.

METHODS: Three months after extraction of the mandibular third and the fourth premolars, implants were placed in the extraction diastema. An orthodontic appliance was constructed on each implant exerting a constant and reciprocal force on the second premolar and the first molar, leading to a mesial movement of the molars and a distal movement of the premolars. Different forces (10 or 300 cN) were applied to the left and the right side of each dog. After 6 months all forces were increased to 600 cN. Time-displacement curves were constructed and the influence of force magnitude on the rate of tooth movement was statistically analysed.

RESULTS: Identical (reciprocal) forces on premolars and molars resulted in faster mean tooth movement of the premolars than of the molars ($P < 0.05$). Within dog comparison of the mean rates of movement of the premolars (10 versus 300 cN) showed no significant differences ($P = 0.41$), while the molars moved faster with 300 cN than with 10 cN ($P = 0.02$). Changing the force from 10 to 600 cN increased the movement rate of molars ($P < 0.01$) and premolars ($P < 0.01$). The change from 300 to 600 cN, however, did not influence the rate of premolar ($P = 0.60$) or molar movement ($P = 0.12$). Premolars moved at a far higher rate than molars in most individual dogs, but in some dogs premolars and molars moved at the same rate. Furthermore, some individual dogs showed no influence whatsoever to the increase in force magnitude on their rate of tooth movement.

CONCLUSION: The effect of orthodontic forces on tooth movement in beagle dogs shows large inter- and intra-individual differences. The effect of changes in force magnitude is highly variable amongst individual dogs. These effects may be related to individual or local differences in bone morphology and/or bone physiology.

43 CHANGE IN FORCE AND RESISTANCE IN TRANSPALATAL DISTRACTION

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AIM: To compare the immediate post-distraction positional changes of the maxillary halves resulting from the use of the

transpalatal distractor (TPD®) in two groups with a different force application and centre of resistance.

SUBJECTS AND METHODS: In the first group of 20 patients, the TPD was placed at the level of the second premolar but pterygomaxillary separation was not carried out. In the second group of 20 patients, the TPD was placed at the first molar level and pterygomaxillary separation was performed. Dental models made prior to and immediately after TPD were digitized. The changes in inter-canine, premolar, and molar distance were recorded. Dahlberg's formula was used to calculate the measurement error.

RESULTS: The errors of variance were less than 3 per cent of the total variances. Width expansion in the first group was 3.57, 3.17, and 22.7 per cent in the canine, premolar, and molar regions, respectively, and in the second group 29.9, 28.3, and 20.8 per cent, respectively. To determine the differential movement of the anterior and posterior parts of the segments, the expansion percentages were related to the original width at the different levels. The expansion ratio was 1.5 times greater at the canine level than at the molar level in the first group. The TPD resulted in parallel expansion in the second group.

CONCLUSIONS: Posterior placement of the TPD combined with pterygomaxillary separation resulted in parallel segment displacement, making it suitable to correct posterior crossbites. Anterior placement without pterygomaxillary separation creates more space in the anterior region, making it ideal to use in a tapered maxilla with anterior crowding.

44 CLINICAL BRACKET BOND FAILURE USING NEW MOISTURE-ACTIVE ORTHODONTIC ADHESIVE SYSTEMS

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AIMS: To clinically evaluate bracket bond failure of three new orthodontic adhesive systems.

MATERIAL: Eight hundred and sixty-five stainless steel brackets bonded to 50 patients using a chemically-cured composite resin (Unite™) in conjunction with a special moisture-resistant primer (Transbond MIP™), a fluoride-releasing light-cured moisture-resistant resin (Assure™) or a water-activated ethylcyanoacrylate adhesive (SmartBond™). A standard composite resin System 11+™ was the control material.

METHOD: The patients were randomly assigned to two groups of 25 patients each. All teeth, except molars, were directly bonded under a split-mouth design. Bond failure rates during a period of nine months were estimated for each adhesive system and the corresponding bracket survival curves were plotted using the Kaplan-Meier product limit estimate. Bracket survival distributions were then compared by means of a log-rank test. Bond failure with respect to tooth location, patient gender and age, malocclusion characteristics, type of initial archwire, and operator were

also evaluated. Bond failure interface was determined according to Adhesive Remnant Index.

RESULTS: The water-activated bonding material recorded the highest bond failure ($P < 0.001$). Assure™ recorded a significantly higher bond failure than either Unite™ and MIP™ ($P < 0.05$) or System 1+™ ($P < 0.01$). Premolars exhibited higher bond failure rates than incisors and canines ($P < 0.001$), while the older age group presented fewer failures ($P < 0.01$). Of the total bond failures 55.2 per cent occurred during the first two months of treatment. The predominant mode of failure was within the bonding material.

CONCLUSIONS: The new moisture-active bonding systems evaluated were found to be clinically efficient, although use of the cyanoacrylate adhesive was characterized by a higher risk of bond failure.

45 BIOMECHANICS IN ORTHODONTICS

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KEYNOTE ADDRESS

The orthodontic profession is a mixture of art, engineering, and medicine. The treatment results are, to a large extent, dependent on favourable growth, patient compliance, and a good functional matrix.

The vocabulary used, e.g. golden proportions, beauty, moment to force ratio, stiffness, and bone metabolism, reflects professional expertise. The use of standard techniques, however, also leads the profession in the direction of a skilled worker. This approach has its advantages but also its limitations.

The purpose of this lecture is to underline the difference between the use of a prefabricated standard technique and the application of a goal-orientated technique, where the force system takes the biological environment into consideration.

On the basis of recent knowledge on bone reaction to mechanical perturbation, the selection of the correct orthodontic appliance for a certain tooth movement will be discussed. The possibilities for building up bone with well-monitored appliances will conclude the lecture.

46 HOW EFFECTIVE IS THE FUNCTIONAL REGULATOR TYPE III?

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AIM: To measure the apical base area (ABA) in the maxilla and mandible and compare the findings between Class III patients and controls.

SUBJECTS: Forty-two Class III patients treated with a functional regulator type-III (FR-III) and a control group of 16 subjects with various minor malocclusions treated with different appliances.

METHODS: Models from the start and end of treatment were measured using a three-dimensional co-ordinate measuring system. In addition to measurements of length, width, and height, the slope of the alveolar processes and the inclination of the first molars were also analysed. Finally, distinct reference points along the alveolus 5 mm from the gingival margin were recorded. After connecting them electronically, they represented the area (in mm²) of the apical base. Differences within a group were tested using the Wilcoxon ranked-test and differences between groups were analysed with the Mann-Whitney *U*-test. An error analysis revealed a measuring error of 1.2 per cent.

RESULTS: The FR-III treatment resulted in a remarkable improvement of the different Class III symptoms. Maxillary and mandibular ABA increased during treatment in the Class III group but not significantly in the control group. The relationship of maxillary to mandibular ABA was at the start and end of treatment smaller in the Class III group than in the control group. The relationship of maxillary to mandibular ABA decreased in the Class III patients, whereas, it increased in the control group. The maxillary intercanine width increased significantly in the experimental and control groups. The mandibular intercanine width increased significantly in the Class III group, but not in the controls. The intermolar width increased significantly in both arches and in both groups. Only in the Class III group was a significant uprighting of the first molars observed.

CONCLUSION: Measurement of the ABA, the inclination of the first molar, and the palatal slope allowed a more comprehensive evaluation of the FR-III effect on the maxillary and mandibular structures. FR-III therapy led to a remarkable increase of the maxillary sagittal and transverse dimensions.

47 ORTHODONTISTS' PERSPECTIVES REGARDING TREATMENT TIMING —A CROSS-NATIONAL STUDY

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AIM: To report the results of a cross-national survey of orthodontists' attitudes regarding treatment timing at various stages of development.

SUBJECTS AND METHODS: One hundred and thirty-seven American, 104 Italian, and 62 Turkish orthodontists (1.2, 15, and 19.4 per cent of the whole professional population). A wide cross-section of gender, age, experience, and years/types of practice was represented. The questionnaire distributed was designed to be self-administered and anonymous.

RESULTS: Only for some occlusal and skeletal conditions did the three groups agree on the ideal dentition stage. The Italian sample was most likely to intervene at the youngest age for 14 of the 41 conditions examined, whereas US orthodontists chose treatment at a significantly younger age than the others for 10 conditions. For most malocclusions, Turkish orthodontists tended to postpone treatment longer

than the other two groups. Italian orthodontists reported more two-phase treatment than either of the other two groups; 1.6 times more than US and 1.9 times more than Turkish orthodontists ($P < 0.001$). For US and Turkish orthodontists, teenagers were the most frequently treated age group (44.4–46.5 per cent, respectively), with less than 10 per cent aged 6–8. Italian respondents reported an average 17 per cent case-load in the youngest group ($P < 0.001$). Cross-national differences also emerged on preferred procedures. US orthodontists used more fixed appliances such as expanders, 2×4 , and lingual arches. Italian orthodontists also used expanders but more functional appliances than the other two groups. Turkish orthodontists were more likely to use removable appliances, but were similar to Italians in their greater use of functional appliances and treatment of oral habits than US orthodontists.

CONCLUSIONS: These results highlight variations in treatment philosophies, despite recent extensive cross-national interaction among orthodontists. However, they also indicate several similarities among these three countries.

48 TOXICITY OF USED ORTHODONTIC ARCHWIRES IN THREE-DIMENSIONAL CELL CULTURES

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AIM: To determine whether orthodontic wires cause toxicity and loss of viability on three-dimensional (3D) cell cultures.

MATERIAL AND METHODS: Three types of orthodontic wire, stainless steel, Nitinol, and TMA ($n = 9$) used in fixed appliances for a period of one month were collected and subjected to two different techniques. Two pieces were cut from each wire. The first piece of wire was placed on 3D cell cultures (reconstituted human epithelium model). After 24 hours, the cell cultures were cut and stained with haematoxylin/eosin. Toxicity was assessed by evaluating the morphological changes and classified into: mild, moderate, and severe. The second piece of each wire was assessed by MTT-test in order to quantify viability of cultures. Copper wires served as the control to determine the morphological picture of severe toxicity and native cell cultures as a baseline.

RESULTS: Morphological studies of the native cell cultures revealed no toxic reactions. The ranking of morphological evaluation from mild to severe toxicity was: TMA < stainless steel < Nitinol. The MTT-test revealed the following mean values: native cell line (negative control) 100 per cent viability, stainless steel 96.7 per cent, TMA 87.4 per cent, Nitinol 85.3 per cent, and copper wires (positive control) 52.2 per cent viability.

CONCLUSION: Histological evaluation with respect to toxicity and measurement of viability in the 3D cell cultures showed no severe toxicity/loss of viability caused by any of the wires. Relative comparison between the different wires

revealed, however, that TMA and stainless steel induced less toxicity/loss of viability compared with Nitinol wires.

49 TRAUMATIC INJURIES AND DEVELOPMENTAL DISORDERS

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AIM: To determine whether intrusive luxation injuries and major maxillofacial traumas can lead to eruption or occlusal development disorders.

SUBJECTS AND METHOD: One hundred and thirty patients admitted either for intrusive luxation injuries in the deciduous dentition or for maxillofacial trauma in the deciduous or mixed dentition. From the initial sample, 50 patients were clinically and radiographically observed to determine possible long-term effects of these traumas on eruption and occlusal development processes.

RESULTS: After intrusive luxation of deciduous teeth, more than one-third of permanent incisors (34.7 per cent) showed various developmental disorders, tooth opacities and hypoplasias being the most common. Some eruption disorders, such as tooth impaction or delayed eruption (14.7 per cent), or root dilacerations (7.3 per cent), were also found. In cases where maxillofacial fractures involved areas with developing tooth germs, there were always long-term effects, namely tooth impactions, ectopic eruptions, crown dilacerations, or deep periodontal defects.

CONCLUSION: Some traumatic injuries can have long-term detrimental effects on eruption or occlusal development processes. Careful clinical and radiological follow-up of patients with dento-alveolar or maxillofacial trauma is strongly recommended to prevent such disturbances and possibly reduce the severity of some orthodontic problems.

50 AN ASSESSMENT OF DEMINERALIZATION WITH AN ION RELEASING CEMENT

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AIM: To determine whether an ion releasing cement (Ariston pHc) reduced demineralization in patients with fixed orthodontic appliances.

SUBJECTS: Twenty-five subjects were assessed for demineralization after fixed orthodontic therapy. The total treatment period was 1.5 to 2.6 years (mean $1.9 \pm \text{SD } 0.2$). All subjects were right-handed brushers and residents of a non-fluoridated area.

METHODS: A random prospective trial was carried out using a split mouth technique to cement brackets with Phase II (a fluoride exchange composite resin) as the control and Ariston pHc (OH^- and F^- and Ca^{2+} releasing composite resin) as the test material. A double-blind assessment of demineralization was carried out three months after debonding. An index was designed to measure the

demineralization. The difference in demineralization between control and test side was compared. A within-person analysis was performed as each patient had brackets placed in the mouth using the test (Ariston pHc) and the control material (Phase II). The differences in the demineralization index between the test and control side were obtained for each patient. Negative scores indicated that the demineralization on the Ariston side was less. Paired *t*-tests on these differences were performed and 95 per cent confidence intervals were obtained using the *t*-distribution.

RESULTS: A reduction in demineralization was found with Ariston pHc ($P < 0.001$).

CONCLUSION: The ion releasing composite resin Ariston pHc shows promise as a potential agent for cementing brackets, as demineralization was considerably reduced.

51 VERTICAL FACIAL FORM, DENTAL OCCLUSION, AND THE HUMAN MASSETER MUSCLE

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AIM: To investigate the relationship between vertical facial form (VFF), dental occlusion, and myosin heavy chain (MyHC) expression and fibre profile in the masseter muscle. **MATERIAL:** Masseter muscle biopsies from 38 subjects undergoing orthognathic surgery together with pre-treatment and pre-surgical cephalometric radiographs and study casts.

METHODS: The subjects were grouped, following cephalometric analysis, into long face syndrome (LFS) ($n = 13$), short face syndrome (SFS) ($n = 11$), and VFF ($n = 14$). Protein and mRNA expression for six MyHC isoforms were quantified by Western and Northern analyses, respectively. Fibre cross-sectional area (CSA) and fibre MyHC isoform expression were analysed using a computer software package (TEMA, Denmark) following immunohistochemistry. The number of occlusal contacts was assessed from pre-treatment and pre-surgery study casts articulated in the intercuspal position. A pilot study had determined that this method accurately represented the number of occlusal contacts assessed clinically. The data were analysed statistically using multivariate multi-level modelling.

RESULTS: Fibre CSA was significantly smaller in LFS subjects than in either VFF or SFS subjects ($P < 0.001$). However, the number of fibres of a particular type and the level of expression of the perinatal MyHC isoform were dictated by the number of pre-surgical occlusal contacts ($P < 0.001$). The expression of perinatal MyHC was also significantly correlated with cephalometric parameters indicative of LFS ($P = 0.004$).

CONCLUSION: The increased expression of perinatal MyHC in the masseter of subjects with a reduced number of occlusal contacts is indicative of muscle fibre disuse atrophy. These data, together with previous evidence on the beneficial effects of masseter muscle training on the development

of LFS, suggest that it is important to achieve a good occlusal result at the end of post-surgical orthodontics in order to prevent relapse in LFS subjects.

52 TISSUE ENGINEERING FOR CLEFT PALATE SURGERY

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AIM: Histological characterization of mucosal substitutes containing cultured keratinocytes on a dermal matrix. The overall aim is to develop an implantable mucosal substitute that limits the iatrogenic effects of cleft palate surgery.

MATERIAL: Palatal mucosa and skin of the beagle dog, artificial matrices (collagen I matrix, collagen I-elastine matrix, and collagen I-GAG matrix), human and dog donor dermis.

METHODS: Mucosal keratinocytes were cultured from palatal biopsies. Subsequently, the keratinocytes were seeded onto the matrices and cultured for 7, 14, and 21 days. Samples were embedded in paraffin for histological and immunohistochemical analyses. Epithelial morphology was characterized with haematoxylin and eosin staining. Immunohistochemical analyses were performed to detect the presence of the cytokeratins 10 and 16, and the basal membrane component, heparan sulphate. Skin and palatal mucosa samples served as normal controls.

RESULTS: A multilayered stratified epithelium formed on top of both donor dermis. Cytokeratin 16 and heparan sulphate were detected in these epithelia. Both the organization and differentiation of these cultures were similar to normal mucosa. In contrast, keratinocytes cultured on all artificial matrices demonstrated ingrowth into the matrix with the appearance of focal keratinisation within cell clusters.

CONCLUSIONS: Beagle dog keratinocytes form a keratinized epithelium on top of both types of donor dermis. These substitutes are similar to normal mucosa and might be suitable for implantation in the palate of the beagle dog. The artificial matrices might be improved by adding a surface layer of a smaller pore size to prevent ingrowth of keratinocytes. In the near future, autologous keratinocytes cultured on donor dermis will be implanted on the palate of beagle dogs as a model for tissue repair after cleft palate surgery.

53 IATROGENIC FAILURES IN ORTHODONTICS—FACTS AND MYTHS

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KEYNOTE ADDRESS

It has often been claimed that certain orthodontic dentofacial and orthopaedic measures performed by the orthodontist will be harmful to the patient's teeth, periodontal tissue, temporomandibular joint (TMJ)

components, and/or craniomandibular function. Although some iatrogenic sequelae are real, others are more or less fictitious and unproven by research.

This presentation will deal with failures occurring during orthodontic therapy. A differentiation will be made between failures caused by the patient, the operator, and those that have no attributable cause. Clinical cases will be presented. Furthermore, in using the Herbst appliances as a scientific tool, special attention will be given to some iatrogenic myths: (1) Proclination of the lower anterior teeth results in gingival recessions and post-treatment incisor crowding. (2) Occlusal overload causes root resorption, gingival recession and marginal bone loss. (3) Bite jumping treatment results in adverse changes of the TMJ components (condyle, fossa, and disc) and/or craniomandibular dysfunction.

54 GROWTH PREDICTION AND TREATMENT EFFECTS IN DEEP OVERBITE CORRECTION WITH THE VARIABLE ANCHORAGE STRAIGHTWIRE TECHNIQUE

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AIM: To predict growth and retrospectively evaluate the net effect of treatment using the variable anchorage straightwire technique (VAST).

SUBJECTS: Two groups were used: a control group, consisting of 30 untreated post-normal Swedish individuals with a mean age of 11.2 years (20 females, 10 males), and a treated group of 29 Swedish patients, mean age 12.8 years (14 females, 15 males), all post-normal and with a deep bite, treated extraction or non-extraction with the VAST technique by the same orthodontist.

METHOD: The prediction of growth according to Ricketts' analysis was used to estimate the expected growth increments. It was first used in the control group to determine its validity and was then applied to the treated group to evaluate the net effect of treatment. Cephalometric analyses according to Pancherz and Ricketts were carried out, and paired *t*- or Wilcoxon signed rank tests were used for analysing the treatment results.

RESULTS: In general the method of predicting growth in the Swedish material according to Ricketts' analysis was found to be reliable, apart from the inclination of the lower incisors, where the proclination had been underestimated. The treatment effects were minor on the skeletal variables (reduction of SNA and ANB), and major on the dentobasal variables (reduction of overbite and overjet, proclination and relative intrusion of lower incisors, extrusion of molars and increased lower face height). The upper molars were distalized in the non-extraction, but mesialized in the extraction group.

CONCLUSION: In the VAST technique, bite opening in post-normal growing patients was achieved mainly as a consequence of dental effects from the variation of tipping and translation of individual teeth.

55 CONDYLAR BONE RESORPTION IN HUMANS DURING HERBST TREATMENT

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AIMS: Temporomandibular joint (TMJ) condyles possess the capability to change morphology during biomechanical loading by modelling and remodelling. The effects have been detected during Herbst treatment using CT-scanning and radiographs of condyles. The purpose of this report is to present possible condylar bone resorption elicited during Herbst treatment, and bone healing changes followed up to 4 years after treatment.

SUBJECTS AND METHODS: Three hundred and twenty consecutively treated patients with the Herbst appliance in the period of puberty to adulthood. 'Standardized' dental tomograms were obtained with a Siemens Orthopan 5 with the incisors in edge-to-edge contact biting on a 1-cm thick block before and during Herbst treatment, after removal of the appliance and yearly thereafter up to 4 years after treatment. Skeletal ages were assessed according to Helm *et al.* (1971).

RESULTS: Two condyles, belonging to different subjects and gender around puberty, showed pronounced remodelling resorption of the cortical and spongy bone in the mesio-cranial aspect of the condyle and formation of new bone in the disto-cranial region of the condyle during Herbst treatment. The resorption of the bone surface was later refilled and covered by a layer of corticalis. Condylar morphology was re-established in one subject (a male), the other was stable with a changed morphology (a female). The newly formed bone was stable, and no TMJ problems were observed radiographically. Both patients were satisfied with the morphological and functional result.

CONCLUSIONS: The difference in bone reaction can be explained as an extreme difference in speed of the turnover process initiated by the Herbst biomechanics.

56 TREATMENT PLANNING IN ORTHODONTIC-BONE DISTRACTION CASES WITH VERTICAL RAMUS ELONGATION

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AIM: To suggest and demonstrate a method for calculation and prediction of the direction of the vector of distraction in subjects needing unilateral elongation of the ramus.

SUBJECTS AND METHODS: Six asymmetric patients with a short ramus on one side in whom unilateral distraction osteogenesis was planned. The vector of distraction was detailed using postero-anterior and lateral cephalograms in order to predict the direction and amount of distraction. Autorotation of the mandible was taken into consideration and movement of the mandible was simulated in the planning. This simulation was controlled on a stereolithographic

model based on CT-scanning. The planned direction was transferred to the patient using a fixation appliance holding the distractor with respect to the occlusal plane. The direction and movement of the mandible were evaluated on lateral cephalograms after insertion and at the end of distraction. The mandible was supported on a splint during distraction and elastics were used to limit side-effects of the distraction.

RESULTS: The transfer procedure secured a direction of the distraction appliance in concordance with the planned vector. The treatment planning and the simulation of distraction gave a fairly safe movement of the mandible, although unwanted side-effects were seen. Two of the six patients experienced a posterior rotation of the mandible.

CONCLUSIONS: In bone distraction where movement is unpredictable, it is important to plan and simulate the surgical movement in order not to leave the orthodontist with insoluble problems in arch relationships and occlusion. The suggested method gives a solution for planning a treatment of combined orthodontics and bone distraction.

57 COMBI-PULL HEADGEAR AS ANCHORAGE IN CLASS II EXTRACTION CASES

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AIM: To evaluate: (a) whether the use of combi-pull headgear is efficient in the maintenance of anchorage in premolar extraction cases and (b) whether vertical development of the face and/or growth of the maxillary complex is influenced after headgear application.

MATERIAL: Fifty-seven lateral headfilms from growing Caucasian Class II patients who had been treated with fixed appliances and edgewise mechanics, including extraction of premolar teeth. Forty patients formed the experimental group (mean age 11.7 years, treatment duration 18.6 months, and headgear application 10.8 months) and 17 patients the control group (non-headgear group: mean age 12.6 years, treatment duration 17.6 months).

METHODS: The horizontal and vertical displacement of the maxillary first molar, as well as various cephalometric variables, were measured and subsequently evaluated by superimposition of the pre- and post-treatment lateral radiographs using the software program, PorDiosW.

RESULTS: Both types of treatment, with and without headgear, resulted in a forward displacement, extrusion and mesial tipping of the maxillary first molar. However, headgear application resulted in a more significant molar extrusion compared with the control group ($P < 0.01$). The mandibular rotation was not influenced. SNA angle was reduced, indicating that forward displacement of the maxilla was inhibited after headgear application. The chronological age of the patients, headgear application time, and treatment duration had no impact on the treatment outcome.

CONCLUSION: It seems that combi-pull headgear is not efficient in maintaining anchorage in the sagittal plane of space, and can be useful only in selected deep bite cases.

58 EXPERIMENTAL AND CLINICAL ASPECTS OF BONE FORMATION IN ORTHODONTICS

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AIM: Understanding the mechanism of the action of demineralized bone matrices (DBM) provides a sound experimental precedent that allows these materials to become a part of our daily clinical practice. The aims of this study were: (1) to quantitatively assess the bone inductive ability of different DBM; and (2) to demonstrate the various clinical applications of these inductive matrices in clinical orthodontics.

MATERIAL AND METHODS: Forty-two critical size defects were created in the parietal bone of 21 adult New Zealand white rabbits. Twelve defects were grafted with DBM prepared from intramembranous bone (DBM_{IM}) alone, or prepared from endochondral bone (DBM_{EC}) alone and DBM_{EC} mixed with autogenous bone. New bone was quantified using image analysis.

SUBJECTS: Five orthodontic patients with alveolar and periodontal bony defects caused by trauma, accidental bone loss, or periodontal disease will be presented.

RESULTS: DBM_{IM} produced 189 per cent more new bone than DBM_{EC}. EC-DBM_{IM} produced 414 per cent more bone than EC bone alone. Post-operative follow-up (1–3 years) showed a successful outcome. Teeth were successfully moved into the repaired defects and endosseous implants were placed into the augmented ridges.

CONCLUSIONS: DBM_{IM} produces more bone than DBM_{EC}. These bone matrices are effective graft materials that warrant wider clinical application.

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59 EFFECT OF ORTHODONTIC FORCE ON GINGIVAL CREVICULAR FLUID VOLUME IN JUVENILE AND ADULT PATIENTS

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AIM: To analyse the effect of orthodontic force on the volume of gingival crevicular fluid (GFC) in two age groups. **SUBJECTS:** Forty-three juvenile male patients (11 ± 0.65 years) and 41 adult male patients (24 ± 1.55 years).

METHODS: In each subject one upper lateral incisor was used as the experimental tooth and the contralateral tooth served as the control. Orthodontic appliances were placed on both sides. The appliance on the experimental side was activated with a labially orientated tipping force of 70 cN, while on the control side it was not activated. GCF was

sampled at the experimental and control sites just prior to force activation and 24 hours thereafter. GCF volumes were determined with a Periotron 6000, which had been calibrated with human serum. Data were statistically analysed after log-transformation by two-tailed paired *t*-tests.

RESULTS: At baseline, the volume in the juvenile group was significantly larger than in the adult group ($P < 0.001$). Placement of orthodontic appliances without activation did not affect GCF volumes in either juveniles or adults ($P = 0.395$). Activation of the orthodontic appliance for 24 hours resulted in a significant increase of GCF volumes in adults ($P = 0.014$), but not in juveniles ($P = 0.937$). However, the significant differences between juveniles and adults persisted ($P < 0.001$).

CONCLUSION: Juveniles and adults show differences in GCF production at baseline level. Activation of orthodontic appliances for 24 hours results in an increase of GCF volumes in adult patients, but not in juveniles. These differences between juvenile and adult patients may be a result of the variations in the efficiency of orthodontic tooth movement between the age groups.

60 ORTHODONTIC TOOTH MOVEMENT THROUGH NEW BONE INDUCED BY GRAFT MATERIALS

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AIM: To prove whether it is possible to orthodontically move teeth through new vital bone induced by xenograft materials.

MATERIAL: Twenty-eight minipigs 15–22 months of age, divided into three groups. Four served as a control group, and 12 were included in each biomaterial subgroup. OsteoGraf/N (inorganic bovine bone matrix) and Bioglass (bioactive ceramics) were used as the graft material. Individualized tooth bands with soldered hooks were used to insert NiTi coils.

METHOD: Under local anaesthesia the following procedures were undertaken: (T0) Impressions to make cast models, periapical radiographs and lateral window osteotomies in the edentulous region between the canine and the first premolar. The xenograft material of choice was packed into the cavity. (T1: 1 month) Placement of the orthodontic appliance and radiographic control of bony healing. (T2: 2 months) Radiographic control. (T3: 6 months) Biopsies were obtained and placed in 10 per cent neutral buffered formalin. The specimens were processed using an undecalcified technique (Technovit 7210 VLC) following which they were sectioned and stained for histological analysis.

RESULTS: Vital bone formation for each experimental group was obtained. This new bone was histologically like cortical bone. During orthodontic tooth movement external lacunae resorption was observed in the roots at the apex and in the pressure surface. When the mesial root began to make contact with the new bone, there was progressive and total

destructive resorption. However this destruction did not occur on the distal root. There was no difference between the two experimental groups. The control group showed lacunae root resorption in the apex and in the pressure root surface, normally associated with orthodontic movement.

CONCLUSION: This long-term experimental study shows that it is not possible to move teeth through new bone induced by the xenograft materials employed.

61 A TWO-YEAR POLYSOMNOGRAPHIC FOLLOW-UP STUDY OF ORAL APPLIANCES IN PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA

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AIM: To examine the long-term effects of a removable mandibular protrusive appliance in patients with obstructive sleep apnoea (OSA) with respect to changes in the respiratory parameters and sleep stages.

SUBJECTS AND METHODS: Twenty-six patients (24 males, 2 females; mean age 55.2 years, mean body mass index 27.8 kg/m²) with the polysomnographic diagnosis of mild to moderate OSA, who were treated successfully with a protrusive appliance according to the first control polysomnography after 6–12 weeks (T₁). Polysomnographic follow-up studies were performed 6–12 months (T₂) and 18–24 months (T₃) after insertion. In addition a subjective assessment of daytime sleepiness, snoring, and sleep quality was carried out.

RESULTS: There was a therapeutic effect on the apnoea–hypopnoea, apnoea and oxygen desaturation indices during the follow-up period. At T₂ the results were maintained ($P < 0.001$). However, a decline in the respiratory parameters from T₂ to T₃ ($P < 0.01$) was observed. In five subjects (19.2 per cent) the respiratory parameters decreased due to an increase in weight and loss of dental retention of the appliance. In two of these the results were improved by adjusting the amount of mandibular protrusion. Statistically at no time-point were the sleep stages altered. The subjective assessment did not always correlate with the polysomnographic outcome.

CONCLUSION: The appliance used was effective in treating patients with mild to moderate OSA. However, it is still unknown whether this treatment concept can be recommended as a life-long therapy. Further critical long-term follow-up studies of these patients are required.

62 EFFICACY AND PREDICTIVE CORRELATES OF AN ORAL APPLIANCE IN THE TREATMENT OF OBSTRUCTIVE SLEEP APNOEA

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AIMS: To investigate the efficacy, side-effects, and compliance of an oral appliance (OA) in treating mild to

moderate obstructive sleep apnoea (OSA). In addition, demographic features, polysomnographic data, dental characteristics, and the dimensions of the registration bite of the OA were tested on the predictive value of treatment outcome.

METHODS: Twenty-eight patients with confirmed OSA were recruited. OAs were fabricated individually after obtaining baseline evaluations. Re-assessments were conducted after 6 weeks regular use of the OA.

RESULTS: As a group, apnoea-hypopnoea index (AHI) decreased from 25.6 ± 8.8 to 6.7 ± 6.0 ($P < 0.001$). Blood oxygen saturation, arousal index and daytime sleepiness also significantly improved. Side-effects were minor and temporary. The compliance was 6.1 nights/week. Nineteen patients (68 per cent) were considered as good responders who achieved a post-treatment AHI < 10 . The other nine who had post-treatment AHI > 10 were poor responders, although they demonstrated significant improvement in most OSA symptoms. One patient, for unknown reasons, deteriorated with the use of an OA. Compared with poor responders, the good responders had significantly less severe pre-treatment AHI and a trend to greater anterior vertical opening in the OA. Treatment outcome was correlated only with the pre-treatment AHI ($R^2 = 0.82$, $P < 0.001$).

CONCLUSIONS: The OA is an effective alternative in treating most patients with mild to moderate OSA, with minor side-effects and good compliance. However, polysomnographic evaluation is necessary after OA delivery so as to eliminate any unpredictable worsening in sleep apnoea. A better response was achieved in those with milder OSA.

63 IMPROVING PATIENT COMPLIANCE AND SAFETY WITH EXTRA-ORAL TRACTION

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AIM: To improve the safety standards and the hours of wear of the facebow used with headgear; to determine the minimal travel required for a safety release mechanism, and to monitor the hours of wear with a new simple timing device fitted in the release modules.

SUBJECTS: Six hundred and ninety-seven consecutively treated patients requiring extra-oral traction were fitted with the Nitom locking facebow. Circumferential neck measurements were obtained of 105 consecutive children referred for orthodontic treatment. Twenty patients were fitted with timing devices.

METHODS: The Nitom facebows were fitted in nine different orthodontic practices by 12 orthodontists. Data were collected over a two-year period. The circumferential neck measurements were taken at four different head positions to determine the minimal travel required for a safety release module to reduce the catapult effect of the extra-oral traction to a minimum. Twenty patients fitted with the Nitom locking facebow were also fitted with Affirm

timing modules. These were read at each review, via an infrared reader, using the Compliance Science software system on a personal computer.

RESULTS: All patients successfully used the Nitom locking facebow for a total of 166,550 nights. The detachment rate at night was reduced to less than 1 per cent compared with a historical control of 65 per cent. The neck measurements suggested the minimum travel required per module (per side) was 25 mm. The Affirm timing devices confirmed that the Nitom locking facebow was worn and provided useful additional information to improve compliance.

CONCLUSION: The standard facebow should be replaced by a self-retentive facebow. The minimum travel of the module is suggested to be 25 mm. The Affirm timing device is a very useful compliance auxiliary.

64 EXPRESSION OF SOX9 IN THE MANDIBULAR CONDYLE

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AIM: To quantitatively assess the temporal expression of SOX9 protein in the condyle during normal growth and during active mandibular advancement.

MATERIAL AND METHODS: One hundred and twenty female 35-day-old Sprague Dawley rats were randomly divided into eight groups with 10 and five rats in each experimental and control group. The experimental group was fitted with mandibular advancement appliances. They were sacrificed on days 1, 3, 5, 7, 9, 11, 14, and 17. Sections were cut through the condyle at the sagittal plane. Immunocytochemistry was performed to identify SOX9 protein by anti-SOX9 antibodies. The expression level was measured quantitatively by the LEICA QWin image analysis system.

RESULT: Expression of SOX9 protein was concentrated in the resting and proliferative zones of the condyle. The peak of expression was observed at day 5 in the experimental group and at day 9 in the control. The expression was significantly more in the experimental group compared with the control. The posterior part of the condyle expressed more SOX9 in both the experimental and control groups than the anterior and posterior parts.

DISCUSSION AND CONCLUSION: These results provide the first demonstration of the presence of SOX9 protein in the rat mandibular condyle. The SOX9 protein expression was upregulated and the maximum level was attained earlier during active mandibular advancement. Since SOX9 protein is a transcription factor that regulates mesenchymal cell differentiation into chondrocytes, it can be speculated that active mandibular advancement enhances and accelerates differentiation of the mesenchymal cells into chondrocytes.

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65 MALOCCLUSION AND INCREASED CARIES RISK—IS THERE A CONNECTION?

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AIM: To evaluate the connection between malocclusion and dental health, different types of malocclusion were assessed based on preventive aspects considering their time of formation and degree of development.

SUBJECTS: In a cross-sectional study 8864 children from Rostock were assessed. Development of the dentition and dental health were examined in the deciduous dentition (mean age 4.7 years) and the early mixed dentition (mean age 8.9 years).

METHODS: Dental health was judged by evaluating dmf-t and DMF-T indices. Malocclusions were divided into nine groups according to their main symptoms. Detailed information of irregularities of the antero-posterior, transverse, and vertical dimension in the anterior and posterior segments was registered on two different sheets for primary and mixed dentitions and permitted evaluation of all symptoms of malocclusion for each child. Clinical examination was performed by one orthodontist and one dentist from the public health department in Rostock. Statistical analysis (Chi², Kruskal-Wallis *H* and Mann-Whitney *U*-tests) was carried out.

RESULTS: Prevalence of malocclusion increased significantly from the deciduous to the mixed dentition ($P < 0.001$). Prevalence of deep bite, overbite, and crowding increased significantly with age. Although prevalence of overjet decreased, its size increased significantly with age ($P < 0.001$). There was no statistically significant difference between the dmf-t values in the primary dentition in subjects with and without malocclusion ($P = 0.319$). There were, however, statistically significant differences in the mixed dentition for dmf-t ($P < 0.001$) and DMF-T ($P < 0.001$) indices. Mandibular overjet ($P = 0.013$) and lateral crossbite ($P = 0.050$) were significantly correlated with an increased caries risk in the mixed dentition.

CONCLUSION: Preventive and early treatment measures in orthodontics and paediatric dentistry are needed, especially in subjects with increased overjets. The co-operation between orthodontists and dentists needs to be strengthened, as higher caries risk and malocclusion is evident from this study.

66 SKELETAL CLASS III MALOCCLUSION—ORTHOGNATHIC SURGERY OR ORTHODONTIC THERAPY?

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AIM: Not all adult subjects with Class III malocclusions are candidates for surgical correction. Therefore, patient assessment and selection remain of prime importance in the

process of diagnosing and treatment planning. The aim of this investigation was to separate subjects with a skeletal Class III malocclusion who could be treated by orthodontics alone from those who required orthognathic surgery.

MATERIAL AND METHOD: In order to obtain a sufficiently robust model that is applicable to patients outside the study, a large sample size was a prerequisite. The present investigation was, therefore, designed as a multi-centre study (Orthodontic Departments of the Universities of Frankfurt, Heidelberg, and Würzburg). In total, the cephalograms of 175 adult patients with a Class III malocclusions were analysed. The orthodontic group comprised 87 patients and the surgery group 88 patients. Twenty linear, proportional, and angular measurements were made. Stepwise discriminant analysis was applied to identify those dento-skeletal variables that best separated the subjects into the groups.

RESULTS: The discriminant function model was highly significant ($P < 0.001$). Ninety-two per cent of patients were correctly classified. The following variables were extracted: Wits appraisal, length of the anterior cranial base (S-N), M/M ratio, and lower gonial angle. The resulting equation was: individual score = $-1.805 + 0.209 \cdot \text{Wits} + 0.044 \cdot \text{S-N} + 5.689 \cdot \text{M/M ratio} - 0.056 \cdot \text{Go}_{\text{lower}}$.

CONCLUSION: Using discriminant analysis, correct classification of adult Class III malocclusion patients succeeded to a very high degree. From all variables, the Wits appraisal was the most decisive parameter.

67 THE COMBINATION 'REVERSE HEADGEAR AND ACTIVATOR' IN

SUBJECTS WITH A RETRUDED LOWER ARCH

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AIM: To compare the effects of two methods of treatment of Class II malocclusions due, at least in part, to retrusion of the lower dental arch.

MATERIAL: Cephalograms of 30 patients treated with an activator combined with reverse headgear to the lower arch were compared with 26 patients treated with an activator combined with conventional antero-posterior headgear. All patients had a second stage of treatment with a fixed appliance and had a Class I relationship and normal overjet at the end of treatment.

METHOD: Three cephalograms were available for each patient: (T1) before the start of treatment, (T2) after the first stage, and (T3) at the end of treatment. Statistical analysis included means, standard deviations, and *t*-tests for dependent and independent samples.

RESULTS: In the conventional headgear group, there was retraction of the maxilla and of the upper incisors and a clockwise cant of the palatal plane at the end of the first stage of treatment. In the reverse headgear group, the symphysis showed less advancement and diminution of its width and the lower incisors showed vestibular tipping. However, during alignment with fixed appliances in both groups, most of these

effects showed a type of rebound. The differences between the two groups at the end of active treatment was that Pogonion was in a more retruded position in the reverse headgear group, soft tissue chin was more backward and the width of the symphysis was smaller.

CONCLUSIONS: In some selected Class II malocclusion subjects with a strong chin and a marked labiomental fold, the use of reverse headgear has a positive aesthetic impact.

68 STIMULATION OF ERUPTION OF IMPACTED UPPER INCISORS

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AIM: Evaluation of the modified window technique to stimulate the eruption of impacted maxillary incisors.

SUBJECTS: Thirty patients (16 boys, 14 girls; mean age 10.6 years) in whom 42 impacted upper incisors were surgically exposed during the period 1997–1998 using a modification of the window technique.

METHOD: The modified window technique has been used since 1979 and is a radical exposure technique in the treatment of the majority of impacted teeth. The impacted or in its eruption obstructed tooth is exposed by a minimal gingival tissue excision. This window has to remain open, with the help of a wound pack or chewing gum, to allow spontaneous eruption of the impacted element. In several cases the window has remained opened by an apically positioned flap.

RESULTS: Eighteen supernumerary teeth were removed during surgical exposure of the upper incisor ($n = 42$).

First surgical exposure 39

Second surgical exposure 2

Extraction due to dilacerations 1

Thirty-nine incisors erupted spontaneously in a mean eruption time of three weeks and the patient could return to the dentist or orthodontist for further treatment.

CONCLUSIONS: (1) Eruption of impacted upper incisors is, in the majority of cases, stimulated by exposing the teeth with the help of the modified window technique. (2) There is no need to place a bracket during the operation and therefore less chance of idiopathic side-effects. (3) The differences in gingival contouring after a modified window or apically positioned flap need further investigation.

69 THE SMILE IN DYNAMIC MOTION

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AIM: Recording and evaluating a patient's smile is an integral part of orthodontic diagnosis and treatment planning. However, the objectivity of this type of assessment is questionable and has given rise to controversy. The aim

of this study was to measure and analyse the dynamics of the spontaneous smile in relation to time.

SUBJECTS AND METHODS: Ten Caucasian subjects (5 males, 5 females) were filmed while watching a video projection. For the purposes of the study, the video was chosen to be a comedy and all the participating individuals were completely unaware of the filming. Two complete 'smile cycles', i.e. from neutral position to maximum smile, were subsequently selected from the videotaped session of each patient. All frames of the video sequences were digitized and the following were measured: (1) smile width (horizontal distance between the corners of the mouth); (2) vertical smile opening (vertical distance between the upper and lower lip at the midline); and (3) degree of upper lip elevation (vertical distance from the alar base of the nose to the most inferior point of the upper lip at the midline). The measurements were plotted against time and their time-related changes were analysed. Frame rate was 25 frames per second.

RESULTS: The smile cycles proceeded in a staged fashion. Three clearly distinguishable phases were identified: (1) an attack period, from neutral state to maximum smile; (2) a sustaining period; and (3) a fade-out period. With regard to the first phase, measurements revealed a rapid transition from neutral position to maximum smile, with an average duration of 0.25 seconds. In contrast, the decay phase was of a generally greater duration, an average of 0.30 seconds, and followed a variable pattern, sometimes being interrupted by a sustaining phase.

CONCLUSIONS: The majority of the spontaneous smiles recorded in dynamic motion, when measured and graphically represented, seem to evolve in a predictable manner in relation to time. There are three distinct phases; the first, or attack phase, seems to be the most rapid and consistent.

70 LONG-TERM FOLLOW-UP OF EARLY TREATMENT OF FORCED CROSSBITE AND TEMPOROMANDIBULAR DISORDERS

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AIM: To determine whether there are differences in prevalence and duration of temporomandibular disorders (TMD) and associated symptoms between individuals subjected only to early orthodontic treatment and individuals who also received additional later treatment, because of relapse of the crossbite.

SUBJECTS: Forty-four subjects (mean age 21 years), who at 4 years of age had been treated for unilateral forced crossbite by grinding or maxillary arch expansion, were 16–19 years later followed-up by questionnaire about their present condition concerning TMD. Twenty-two had received only early treatment (early group) and 22 late treatment (late group). Fourteen of the patients who received late treatment also received early treatment. Twenty-nine of the subjects were also examined clinically.

Eighteen of these subjects had only received early treatment at the age of four (early group), while 11 of them had additional treatment in the mixed or permanent dentition (late group).

RESULTS: No significant differences were found between the early and late groups regarding signs and symptoms of TMD. The majority of the young adults who had undergone orthodontic treatment had well-functioning masticatory systems and TMD signs and symptoms were rare.

CONCLUSION: Relapse of early orthodontic treatment and further treatment need does not influence the later status of subjective symptoms or clinical signs of TMD in young adults.

71 FOCAL HYALINIZATION LIMITS EXPERIMENTAL TOOTH MOVEMENT IN 'SLOW MOVERS'

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AIM: To evaluate cellular activity during orthodontic tooth movement.

MATERIAL: Fifteen young adult beagle dogs.

METHODS: After extraction of the mandibular third and fourth premolars, implants were inserted in the diastemas. Three months later an orthodontic appliance was placed that exerted a continuous and constant reciprocal force of 300 cN on the second premolar and first molar. Time-displacement curves were constructed. Dogs were killed after 1, 4, 20, 40, or 80 days for histological evaluation; haematoxylin and eosin for general tissue survey, alkaline phosphates for active osteoblasts, and tartrate resistant acid phosphatase for osteoclasts. **RESULTS:** In the first 24 hours the tooth had moved within the periodontal space. Osteoclastic and osteoblastic activity had already increased at the pressure and tension side, respectively, and hyalinization was found in some cases. Later, the curves showed considerable individual differences. Intra-individual differences between premolar and molar displacements appeared to be less pronounced. The 'fast movers' showed areas of direct osteoclastic bone resorption and disruption of the periodontal continuity at the pressure side and osteoblastic deposition of more or less trabecular bone at the tension side. 'Slow movers', however, showed minute patches of hyalinization at the pressure side, often located buccally or lingually of the premolars or the molars. Only a few osteoclasts were present, almost exclusively in the vicinity of the hyalinized areas, leading to direct or undermining resorption. The presence of macrophage-like cells and the ingrowth of young connective tissue indicated the removal of hyalinized tissue. At the tension side, osteoblastic activity was mainly restricted to cavities within the alveolar bone, and only few active osteoblasts were found at the periodontal ligament border.

CONCLUSIONS: Repeated temporary focal hyalinization plays an important role during orthodontic tooth movement in 'slow movers'.

72 SUCCESS RATE OF PALATAL ORTHODONTIC IMPLANT ANCHORAGE

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AIM: To determine the success rate of palatal orthodontic implant anchors (POIA).

SUBJECTS AND METHOD: Twenty-two non-growing patients aged between 15 and 39 years. Each of them received one endosseous POIA (Orthosystem) with a length of 4 mm ($n=6$) or 6 mm ($n=16$) in the median palate for anchorage reinforcement of maxillary teeth.

METHODS: Implant mobility (immobile/mobile) and sound upon percussion (clear, crystalline/subdued) were assessed in the unloaded healing (mean: 12.5 weeks) as well as in the implant loading period (mean: 13 months, 1 week). Changes of implant angulation [(IA): angle between implant axis and line through ANS/PNS] and implant position [(IP): distance between PNS and implant axis on ANS/PNS] were measured on cephalograms taken before and during/at the end of the orthodontic loading period (mean: 13 months, 1 week). A paired *t*-test at a level of 0.05 was used to determine significant differences.

RESULTS: In all patients the implants showed primary stability. In two subjects implant mobility and subdued sound upon percussion as a sign of soft tissue encapsulation were recorded at the one-month control session in the healing period. The remaining implants ($n=20$) showed neither mobility nor a subdued percussion sound at any control session in the different periods. Radiographic evaluation revealed no significant differences in IA (mean: 0.09 ± 0.97 degrees) and IP (mean: -0.1 ± 0.5 mm) between the initial and final measurements.

CONCLUSION: The success rate of POIA was 91 per cent. Failure occurred exclusively in the first month after insertion. Once integrated, there were no clinical signs of loss of integration or radiologically verifiable positional changes under clinically relevant anchorage loading.

73 REPLICATING MESENCHYMAL CELLS IN THE GLENOID FOSSA

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AIM: To quantitatively assess the number of replicating mesenchymal cells during normal growth and during mandibular advancement in the glenoid fossa.

MATERIALS AND METHODS: One hundred and fifty female 35-day-old Sprague Dawley rats were randomly divided into 10 experimental groups (10 rats per group) and 10 control groups (five rats per group). The experimental groups were fitted with functional appliances that positioned the mandible in a continuous forward posture. The rats were then sacrificed after 3, 7, 14, 21, 30, 33, 37, 44, 51, and 60 days. One hour prior to this, bromodeoxyuridine (BrdU), a

chemical marker incorporated into replicating cells, was intravenously injected into the rats. Tissue sections of 7 µm were cut through the glenoid fossa in the sagittal plane and stained with anti-BrdU antibody to evaluate the number of replicating mesenchymal cells. Haematoxylin stain was applied to observe cellular response. Cellular uptake of BrdU was quantified using the Leica Qwin system.

RESULTS: BrdU stained cells were observed in the articular layer and in the chondroblast layer of the glenoid fossa. All experimental groups showed an increase in mesenchymal cell proliferation compared with the control group. Maximum mesenchymal cell replication for the control and experimental groups was observed on days 3 and 7, respectively. A significant increase in the number of replicating mesenchymal cells occurred in the experimental group. **CONCLUSION:** Mandibular advancement leads to an increase in mesenchymal cell replication in the glenoid fossa. This could be a potential contributory factor to the increased amount of bone formation following forward mandibular positioning.

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74 ORTHODONTIC TREATMENT IN ELDERLY PATIENTS—IS THERE AN AGE LIMIT?

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KEYNOTE ADDRESS

This lecture will describe experiences associated with orthodontic treatment in a consecutive series of 36 elderly adults, ranging from 65 to 82 years of age at the start of therapy. All different types of dental malocclusions were represented, but no surgery cases. The patients were treated by one orthodontist. Fixed appliances were used labially in one or both dental arches, for an average duration of one year. In 22 cases, a non-extraction approach was used. Treatment plans and teeth selected for extraction, when needed, differed from what is common in younger patients, and included uncommon and strategic removals. The majority of patients needed mesiodistal recontouring of teeth by grinding, for space reasons and to avoid loss of the interdental gingival papillae.

The observations were unconditionally positive both from the patients and the patients' and the orthodontist's points of view. The aesthetic appliances were well accepted by all the subjects, and treatment was not discontinued in any case. It is concluded that comprehensive orthodontic treatment with fixed appliances is possible even at a very respectable patient age. It is probably wise, however, not to extend the treatment goals as far as in younger adults, or to go beyond the elderly patients' subjective need for correction. Judged from the favourable post-treatment, some compromises to be discussed appeared to be justified.

