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# Meeting abstracts

Abstracts of research presented at the Australian Society of Orthodontists' 21st Congress held on the Gold Coast, Queensland, Australia, 1–5 March 2008.

## **Expression of neural crest markers by human embryonic stem cells: introductory projects**

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*Introduction:* Neural crest cells (NCCs) are a transient migratory population of cells found in all vertebrate embryos. Great strides have been made in the past decade towards elucidating the molecular basis of neural crest induction and although much remains unclear, it appears that it is a process involving several growth factors acting at different stages of embryogenesis.

*Methods:* This study examined the effects of the early addition (Days 0 to 3) of noggin, a Bone Morphogenetic Protein (BMP) antagonist, and the late addition (Days 4 to 7) of BMP4 on the expression of the neural crest markers Msx-1, Snail, Slug, and Pax-7 by human embryonic stem cells (hESCs) co-cultured for 8 days on a feeder layer of mouse PA6 cells.

*Results:* It was observed that the early addition of noggin and the late addition of BMP4 significantly increased the expression of Msx-1, compared to the late addition of BMP4 alone. With regard to Pax-7, it was observed that the late addition of BMP4 significantly increased the expression of Pax-7 compared to the effects of co-culturing on PA6 cells alone.

*Conclusion:* This work may be viewed as a preliminary project to future larger studies with the potential to more definitively ascertain the effects of noggin and BMP4 on the expression of NCC markers by hESCs. This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

## **Relationship of epithelial cells and nerve fibres to experimentally induced dentoalveolar ankylosis in the rat**

**Darren S. Di Iulio, Wayne J. Sampson, Craig W. Dreyer and Mark Bartold**

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*Background:* The function of the epithelial rests of Malassez (ERM) remains unclear. However, it has been suggested that they protect against ankylosis and may have a functional interaction with nerve fibres.

*Aims:* To investigate the distribution of ERM and nerve fibres within the furcations of rat maxillary molar teeth subjected to hypothermic injury, and examine their influence on the development of dentoalveolar ankylosis and root resorption.

*Methods:* The upper right first molars of 30 Sprague Dawley rats were subjected to a single 20 minute application of dry ice ( $-81^{\circ}$ ). Five animals were sacrificed at 7, 10, 14, 18, 21 and 28 days respectively, and paraffin embedded coronal sections were cut through the first molars. Consecutive sections were stained with haematoxylin and eosin, cytokeratin AE1/AE3 and PGP 9.5 immunostains. Counts were undertaken for ERM and nerve fibres within the periodontal ligament of the furcation in experimental and control teeth, and their spatial distribution was noted. The presence or absence of ankylosis and root resorption was also recorded.

*Results:* Ankylosis did not develop in all experimental teeth, and when present, its morphology changed from fine bony trabeculae at 7 and 10 days to dense bony tissue at 18 days. Statistical analysis of the ERM and fibre counts suggested that ERM provided a protective function against the development of ankylosis and resorption. Evidence of an intimate interrelationship between ERM and nerve fibres could not be confirmed.

*Conclusion:* ERM may provide a protective function against ankylosis and root resorption.

This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

### **The effects of nerve growth factor on orthodontic tooth movement in rats**

**Henry S.H. Ho, Wayne J. Sampson, Craig W. Dreyer and Ian A. Ferguson**

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*Background:* Biological responses to orthodontic forces involve various cell types such as osteoblasts, osteoclasts and sensory nerves in the periodontal ligament. Neurotrophins are believed to interact with these cells to initiate the process of bone resorption, particularly during orthodontic tooth movement.

*Aims:* The aim of this research was to investigate the cells responsible for NGF secretion within the periodontal ligament (PDL), pulp and bone and to test the effect that anti-NGF has on orthodontic tooth movement.

*Methods:* Thirty 8 week-old male Sprague-Dawley rats were randomly divided into control and experimental groups. The 14 experimental animals had anti-NGF injected adjacent to the tooth being moved by an orthodontic appliance. Animals were sacrificed at 7 and 14 days.

*Results:* The findings of this investigation indicate that anti-NGF may reduce the rate of tooth movement, but not to a statistically significant degree. TRAP-positive osteoclastic cells were detected in anti-NGF and control groups. However, the TRAP-positive cells were not stained intensely with NGF immunolabelling. On the other hand, cells that were stained positively for NGF, were TRAP-negative.

*Conclusion:* The results suggested that both sympathetic and nociceptive nerves may function in counter balance to modulate bone resorption, and osteoclasts may not be directly responsible for NGF secretion within the PDL and bone.

This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

### **Pain discomfort and irregularity of dentition at initial alignment. Is there a relation?**

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*Introduction:* Fixed appliance treatment is often accompanied by discomfort and pain, especially at

the initial alignment stage of the treatment. The pain perceived during this stage may be related to the degree of irregularity.

*Objectives:* To determine if a correlation exists between tooth irregularity and the pain perceived during alignment, and to compare the effect of two types of levelling archwires used for initial alignment of the lower arch.

*Methods:* Forty-two patients with irregular lower incisors participated in this prospective trial. The patients were assigned randomly to either a group treated with 0.014" Nitinol SE or a group treated with 0.016" Nitinol HA. The pain response was assessed with a Verbal Rating Scale (VRS) during the first week of treatment.

*Results:* When 0.014" Nitinol SE was used there was no statistically significant difference in pain perception between the group with less severely irregular lower incisors (LI1) compared with the group with a greater irregularity of the lower incisors (LI2). When 0.016" Nitinol HA archwire was used, significantly more pain was perceived by the patients in the LI1 group ( $p < 0.01$ ). Within the LI2 group, significantly more pain was experienced with the 0.014" Nitinol SE archwire ( $p < 0.001$ ).

*Conclusions:* The degree of lower incisor irregularity did not influence the pain perception. There was, however, a statistically significant difference between the pain experienced with the 0.014" Nitinol SE and 0.016" Nitinol HA archwires.

### **Analysis of elemental composition using proton-induced X-ray and gamma ray emissions in root resorption craters of rat molar cementum following exposure to systemic fluoride**

**Elaine Lim, David Belton, Gang Shen, Peter Petocz and M. Ali Darendeliler**

Discipline of Orthodontics, Faculty of Dentistry, University of Sydney, Australia

*Background:* Root resorption resulting from orthodontic treatment is an unpredictable adverse effect. There is currently no consensus on how to minimise or prevent the development of this problem. Literature has been sparse examining the potential protective influence of tooth cementum minerals against orthodontically induced root resorption. Fluorine may be extrapolated as an important element, and could have a role in minimising the extent and severity of resorptive lesions.

*Aims:* To examine the effect of systemic fluoride on orthodontically induced root resorption and the mineral content of tooth cementum within these lesions.

*Methods:* Two groups of 7 week-old Wistar rats were exposed to systemic fluoride (100 ppm) or non-fluoridated drinking water for 2 weeks. Orthodontic tooth movement was implemented by a nickel titanium closing coil (100 g). The rats were killed, the molar teeth dissected out and cross-sections cut through the largest mesial mid-root crater. The samples were scanned using the CSIRO-GEMOC nuclear microprobe.

*Results:* Root resorption lesions of the teeth in the Fluoride group were significantly reduced in length and depth ( $p < 0.01$ ). The mineral content of root resorption craters of the Fluoride group had higher concentrations of fluorine and zinc ( $p < 0.01$ ). There was less calcium in craters of the No fluoride group as compared with the Fluoride group ( $p < 0.05$ ).

*Conclusions:* The quality of cementum is influenced by the history of fluoride intake. This in turn may limit the extent of orthodontically-induced cementum resorptive defects.

### **Analysis of elemental composition using proton-induced X-ray and gamma ray emissions in human cementum following heavy and light orthodontic forces**

**Elaine Lim, David Belton, Peter Petocz and M. Ali Darendeliler**

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*Background:* An understanding of cementum structure following orthodontic force may help to increase our understanding of its role in the orthodontic root resorption process and the potential role elements may have in its prevention.

*Aim:* The aim of this study was to conduct an analysis of the elemental composition of human root cementum, following heavy and light orthodontic force using the CSIRO-GEMOC nuclear microprobe machine. Furthermore, a methodology was established for this machine, enabling more accurate readings of cementum than previously published from tooth root samples that could remain relatively unaltered for the scanning process.

*Method:* Four teeth, which met inclusion criteria, were analysed. Buccal directed forces of 25 g (light) and 225 g (heavy) were imparted by 0.016" and

0.017 × 0.025" TMA springs respectively. Following the experimental period of 4.1 weeks the teeth were extracted. Samples were sectioned longitudinally, embedded in epoxy resin, polished and prepared for analysis by the CSIRO-GEMOC nuclear microprobe machine. Six predetermined dentine-cementum points per tooth (800 × 800 μm) were analysed and deconstructed using the Geo-PIXE II Version 3.8 Program.

*Results:* The CSIRO-GEMOC nuclear microprobe machine was able to detect F, Mg, Na, Ca, Fe, Zn and Sr. Orthodontic force below 250 g did not appear to consistently alter the pattern of cementum elemental distribution. However, there was a significant reduction of overall Zn, F and Sr concentrations comparing heavy and light force with controls ( $p < 0.01$ ).

*Conclusions:* Findings indicate that cementum may have the capacity to resist significant element alterations. However, the reduction in Zn and F following exposure to orthodontic force may have implications for subsequent root resorption.

### **Analysis of elemental composition using proton-induced X-ray and gamma ray emissions in human orthodontic root resorption craters**

**Elaine Lim, David Belton and M. Ali Darendeliler**

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*Background:* Cementum is at the interface of orthodontically induced inflammatory root resorption process and its structure may help to elucidate its role in protecting teeth. Zinc and fluorine have been found to be present in cementum. These elements have been noted to modulate osteoclast activity and contribute to the mineralisation of hard tissue. Thus, elemental composition of cementum may play a role in the extent and severity of the resulting lesion. It may also lead to potential preventive measures being elucidated.

*Aims:* To analyse the element composition and distribution in human tooth root surfaces and orthodontically induced root resorption craters. Also, to develop a methodology using the CSIRO-GEMOC nuclear microprobe machine to study cementum and root resorption craters.

*Methods:* A human tooth was subjected to a buccally directed orthodontic force (225 g) using a 0.017 × 0.025" TMA sectional wire. The experimental period

lasted 4.1 weeks. The tooth was extracted. A representative OIRR crater with well-defined and unambiguous lesion margins was identified. The sample was cross-sectioned through the crater and prepared for scanning with the CSIRO-GEMOC nuclear microprobe machine. Geo-PIXE II version 3.8 program was used for analysis.

*Results:* Root resorption crater and normal tooth structure followed the same pattern of mineral distribution. However there was a general reduction of mineral content. Notably, the root resorption crater dentine had higher fluorine, iron and zinc concentrations, compared to equivalent unaffected tooth structure. This may reflect the remineralisation process.

*Conclusions:* The implications of increased fluorine and zinc concentration within the resorption lesion may be that these elements could serve to influence the extent of the resorptive lesion. They may impart a protective effect on the tooth root surface due to their inherent capabilities of limiting osteoclast activity.

### **Natural head position: a photographic method and an evaluation of craniofacial reference planes**

**David Madsen, Wayne Sampson and Grant Townsend**  
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*Background:* Commonly used craniofacial reference planes such as Frankfort horizontal (FH) and sella-nasion (SN) have shortcomings including their variable inter-individual orientation when related to true horizontal (HOR).

*Objectives:* To evaluate the potential usefulness of a range of craniofacial reference planes to HOR including those which have not been investigated before: Krogman-Walker line (KW line), neutral horizontal axis, foramen magnum line and posterior maxillary plane.

*Methods:* A sample of 57 (38 female, 19 males) consecutive, pretreatment orthodontic subjects aged 12 to 18 years were photographically recorded in a standing mirror guided natural head position (NHP). Cephalograms taken at the same time were traced, oriented to a plumb line (true vertical) transferred from the photograph, and measured for statistical analysis. Thirty nine of these subjects were photographically recorded two months later to test the reproducibility of NHP.

*Results:* The variability of the 11 selected craniofacial reference planes related to HOR was generally high.

The planes illustrating lowest variability to HOR were FH and KW line with standard deviations of  $4.6^\circ$  and  $4.7^\circ$  respectively. These, however, showed about double the variation in NHP reproducibility (Dahlberg  $2.1^\circ$ ). The KW line and palatal plane were also oriented closest to HOR on average.

*Conclusions:* KW line and palatal plane are potential substitutes for the commonly used reference planes in the absence of a reliable NHP. However, NHP still represents a more valid craniofacial reference system than the investigated reference planes.

This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

### **Smile arc in Palestinian youths**

**Ma'n Mahfouz**

Orthodontic Department, Arab American University Jenin, Palestine

*Objectives:* To assess the smile arc in Palestinian youths, the number of teeth displayed during smiling, and the impact of the number of teeth displayed on the smile.

*Methods:* A total of 851 Palestinian youths (446 males, 405 females) between 12 and 17 years of age was used. Digital photographs were used to record the smile arc.

*Results:* The results showed that 75.8% of the Palestinian youths examined had a consonant smile arc. A flat smile arc was present in 19.2% and a reverse smile arc in 5%. A statistically significant difference was present between males and females. The results also showed the percentage of teeth displayed during smiling was 5.1% for canines, 16.9% for first premolars, 35.5% for second premolar, 40.3% for first molars and 2.2% for second molars.

*Conclusions:* The smile arc is a good indicator of dentolabial harmony and attractiveness. The number of teeth displayed has an impact on smiling. The smile arc is not independent of sex.

### **Dental arch asymmetry in the mixed dentition**

**Ma'n Mahfouz**

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*Objective:* To quantify and describe dental arch asymmetry in Palestinian children in the mixed dentition.

*Methods:* Dental casts of 40 subjects in the mixed dentition (6–12 years of age) were used. Both boys and girls were used. Arch symmetry/asymmetry was measured by using a computer-aided system.

**Results:** The anteroposterior asymmetry was not as common as transverse asymmetry. With increasing age anteroposterior asymmetry increased in the posterior direction. There was no significant sex or age difference. Early loss of primary teeth was the major cause of asymmetry; this was followed by abscessed teeth.

**Conclusions:** In the mixed dentition transverse asymmetry was more common than anteroposterior asymmetry. Methods to prevent early loss of teeth and abscessed teeth may prevent the development of both types of arch asymmetry.

### **The effects of masseteric nerve section on facial growth in laboratory rats**

**Robert Mayne, Chris van der Poel, Gordon Lynch and Michael G. Woods**

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**Aim:** To determine the effects of denervation and introduction of the  $\beta$ 2-adrenoceptor agonist, formoterol, on muscle volume and underlying skeletal growth.

**Method:** Young (4 week-old) male Sprague Dawley rats were assigned to denervated and  $\beta$ 2-agonist experimental groups. The denervated groups had the left masseteric nerve sectioned, and for the  $\beta$ 2 agonist groups, formoterol was injected directly into the left masseter muscle every 3 days for 8 weeks. Muscle mass, muscle volume (via Magnetic Resonance Imaging), muscle fibre cross-sectional area (CSA), and protein per mass of muscle were assessed and compared with controls. Skeletal changes were assessed via digital radiography.

**Results:** The findings indicate that after surgical denervation of the masseter muscle there are significant volumetric, mass and CSA changes in the muscles, and in the development of the underlying skeletal structures. These post-surgical changes were largely offset by administration of a  $\beta$ 2-agonist formoterol, which attenuated muscle atrophy. Administration of a  $\beta$ 2-agonist alone without surgical denervation led to increases in muscle mass, volume and CSA, however similar changes in skeletal facial form were not observed.

**Conclusions:** The findings indicate that changes in the properties of animal skeletal muscle structure caused by both denervation and  $\beta$ 2-agonist administration can be successfully measured with MRI. This

advances our understanding of the role of the masseter muscle in underlying facial skeletal development and potential therapeutic application of  $\beta$ 2-agonists in orthodontics.

This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

### **Evaluation of two new methods for measuring tooth widths**

**Devan Naidu, Desmond Ong and Christopher T.C. Ho**

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**Objectives:** Measuring tooth widths is a fundamental part of orthodontic treatment planning. Calipers have traditionally been used as the 'gold-standard' for making measurements. This study aimed to determine the validity and reliability of measuring tooth widths and performing a Bolton's tooth size analysis using two new methods, and comparing the results with the traditional method of using calipers.

**Methods:** The sample comprised of 20 study models. Tooth widths were measured using three methods:

1. Digital calipers to record widths directly;
2. Taking digital photos of the models and measuring each tooth on a computer program;
3. Taking impressions which were CT scanned to produce 3D digital models from which tooth widths were measured. The 3D digital models were measured using the DigiModel software. A paired *t*-test was performed to compare the measurements obtained by the two new methods with those obtained with the calipers.

**Results:** There was a statistically significant difference in measurements between DigiModel and the calipers ( $p=0.02$ ), and the digital photos and the calipers ( $p=0.0007$ ). DigiModel had a lower width estimate while the digital photos had a higher width estimate. However, these discrepancies were judged not clinically significant. When used to determine anterior and overall Bolton's ratios, the accuracy of DigiModel and the digital photos was also clinically acceptable. The average reliability scores were 98% for the digital calipers, 98% for DigiModel, and 99% for the digital photos.

**Conclusions:** The validity of DigiModel and digital photos in measuring tooth widths and performing a Bolton's tooth size analysis is clinically acceptable. The reliability of both methods is excellent.

### **Modulation of input from muscle spindles during simulated chewing and correlation with different facial heights**

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**Kemal S. Türker**

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*Introduction:* Current study aims to evaluate the modulating effect of jaw movement on muscle spindle-evoked reflexes from masseter during simulated chewing, and correlating with different facial heights. No work has been done to characterise a relationship, if one exists, between muscle spindles and different facial heights.

*Methods:* 28 consenting participants were included in the study. Reflexes were evoked by 1 and 2 N taps to the upper central incisor. Responses of the jaw muscles to these taps were analysed with IZZY software. Standardized lateral cephalometric radiographs were taken from the participants and analysed for any existing correlation between muscle spindle response and wide spectrum of facial heights.

*Results:* We have found that stimulation of muscle spindles does elicit a significant excitatory reflex during chewing. There is a significant reduction of this reflex excitation during the jaw closing phase, while during the jaw opening phase, no significant modulation was evident. However, it remains to be seen if there is a significant difference in spindle response in different facial proportions.

*Conclusions:* Orthodontic implications can be wide if such a relationship exists. This paper will elicit the importance of physiological studies in order to better understand the underlying function that could be exploited for the cause and effect of different orthodontic modalities.

This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

### **Lower lip changes in surgical correction of Class II malocclusion**

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**William R. Proffit**

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*Introduction:* To test the hypothesis that lower lip response to surgical change in mandibular deficient

patients will depend upon pretreatment face height, vertical change produced with surgery, and addition of a genioplasty.

*Methods:* Patients who had surgery to correct mandibular deficiency were assembled, 50 in each of three groups according to long, normal or short pretreatment face height. Presurgical and post-treatment lateral cephalograms were traced and digitised. Selected soft and hard tissue landmarks were paired to generate ratios of soft-to-hard tissue treatment changes.

*Results:* Different lower lip responses were found between the face height groups. Lip incompetence and lower lip eversion decreased in the long subjects as face height decreased. In the short face group the lower lip unfurled, lengthened and was freed from upper incisor interference as face height increased. Genioplasty further decreased the interlabial gap in long subjects, and enhanced release of the lower lip and flattening of the mentolabial fold in the short group.

*Conclusions:* It is suggested that the appropriate vertical change for the face height of the individual is a key element in the response of the lower lip to surgical correction of the deficient mandible. This variable should be included in future computer prediction algorithms.

### **Correlation between skeletal maturity stages of hand-wrist and cervical vertebra in Brazilian adolescents**

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*Introduction:* To determine correlations between skeletal maturity stages obtained through the evaluation of hand-wrist radiographs and cervical vertebrae analysis in lateral cephalograms.

*Methods:* The subjects were Brazilian adolescents (48 females, 46 males), age range between 9 years 9 months and 17 years 11 months of age at the beginning of orthodontic treatment. Radiographs obtained on the same day were used to assess the concordance and correlation between the two methods. Two trained examiners (DCR/RFH) classified the skeletal maturity stages on the hand-wrist radiographs (HW) using the Helm et al. method (1971), and the cervical vertebra maturation (CVM) according to Baccetti, Franchi, McNamara (2002). The data from both methods were classified into pre-peak, peak and post-peak phases of pubertal growth spurt. Kappa statistics (K) were used to determine the concordance among

examiners and Spearman correlations to establish the correlation between the methods.

**Results:** High concordances of scores were found; intra-examiner (HW:  $K=0.75$ /CVM:  $K=0.678$ ) and among examiners (HW:  $K=0.70$ ; CVM:  $K=0.48$ ). Spearman tests showed moderate correlation between methods ( $R_s=0.763$ ,  $p<0.001$ ). CVM I stage was correlated with pre-peak (75%) and peak (25%) phases in the hand-wrist; CVM II and III stages correlated with pre-peak (50%, 25%) and peak (50%, 70%) respectively. CVM III also showed correlation with post-peak (5%). CVM IV and V showed correlation in peak (33.34%, 14.28%) and post-peak (66.66%, 85.72%) respectively.

**Conclusions:** CVM method correlates well with pre-peak and peak phases in HW and is useful to determine skeletal maturity stage in Brazilian adolescents. Hand-wrist method is still the most reliable tool to identify the skeletal maturity stages during the pubertal growth spurt period.

### **Temporomandibular joint adaptations following two phase therapy: an MRI study**

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**Background:** In recent past Magnetic Resonance Imaging (MRI) has been used to evaluate the effect of bite jumping on the TMJ. In the literature, few MRI studies have evaluated the effects of removable functional appliance (FA) therapy on the TMJ.

**Aim:** The aims of this study were to document the adaptive remodelling changes within the condyle-glenoid fossa (C-GF) complex and the positional changes of the glenoid fossa in the cranium: 1) after removable functional appliance therapy; 2) at completion of the second phase of fixed appliance therapy.

**Methods:** The study was conducted on a sample of 12 growing children with skeletal Class II division 1 malocclusions. The children were treated with either twin block (6 cases) or bionator (6 cases) functional appliances followed by fixed appliances for occlusal settling. Total average duration of the two phase therapy was 28 months. The changes in and around C-GF complex were evaluated using MRI at three stages: pretreatment, after functional appliance therapy and at completion of fixed mechanotherapy.

**Results:** Forward condylar position within glenoid fossa and articular disc retrusion with respect to the

condylar head were significant after FA therapy. However, the condyles assumed a relative concentric position within glenoid fossa while the articular disc resumed its pretreatment position at the end of treatment. Linear measurements from the centre of the external auditory meatus to the postglenoid spine revealed a 1.3 mm forward relocation of the latter along FH plane.

**Conclusions:** Forward relocation of the C-GF complex seems to be one of the mechanisms of action of functional appliances. The internal anatomic arrangement within the TMJ complex, which alters significantly during functional appliance therapy, tends to assume its pretreatment position during the phase of occlusal settlement with fixed appliance therapy.

### **Bolton tooth size discrepancy and its effect on buccal segment intercuspation – ideal and non-ideal occlusions**

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**Olena Kravchuk**

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**Objectives:** To compare the tooth size ratios for ideal and non-ideal occlusions, and to see if tooth size ratios influence the ability to achieve an ideal occlusion. Also, to re-evaluate Bolton's tooth size ratios for ideal occlusions.

**Methods:** Two groups of orthodontic models, comprising equal numbers of males and females, were divided into the Ideal (N=31) and the Non-ideal occlusions (N=48). The Ideal group conformed to Andrew's 6 keys of occlusion, with the canines and first molars within 1 mm of their ideal positions. The Non-ideal group was similar to the Ideal group except for discrepancies in the position of the molars and canines, which were more than 1 mm discrepant from the ideal position. The anterior Bolton's ratio (ABR) and the overall Bolton's ratio (OBR) were determined and compared. Statistical analysis was performed with Minitab Release 15, using the Student *t*-test to compare means. Reproducibility was performed with repeated measurement, and the paired *t*-test using two examiners.

**Results:** There was a statistically and clinically significant difference in ABR and OBR between the Ideal and Non-ideal groups (75.6±1.8% and 90.6±1.4% vs 77.9±1.9% and 91.7±1.6%;  $p=0.000$  and  $p=0.005$  respectively). There was also a statistically and

clinically significant difference between the Ideal group and the original Bolton sample ( $75.6 \pm 1.8\%$  and  $90.6 \pm 1.4\%$  vs  $77.2 \pm 1.6\%$  and  $91.3 \pm 1.9\%$ ;  $p=0.000$  and  $p=0.003$  respectively). However, there was no difference between the Non-ideal group and Bolton's original sample. Further analysis revealed the major difference between the Ideal group and the others was the sizes of the upper anterior teeth which were wider than predicted by the Bolton ratios.

*Conclusions:* Ideal occlusions have a lower ABR than predicted by Bolton ratios. This implies that larger upper anterior teeth or smaller lower anterior teeth than predicted by Bolton make it easier to achieve an ideal occlusion – all else being equal. New ideal tooth size ratios may be required.

This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

### **Muscular and skeletal craniofacial 3D-CT assessment of young orthodontic patients**

**Alwyn Wong and Michael Woods**

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**Damien Stella**

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*Aim:* This study was undertaken to evaluate the relationships between the mandibular muscles and dentofacial morphology in children with different underlying vertical facial patterns utilising 3D-CT.

*Method:* Thirty children (mean age  $12.24 \pm 1.57$  years) underwent cranial CT examination. 3D-CT images were reconstructed for the evaluation of the cross-sectional size, volume, and spatial orientation of the mandibular muscles (masseter and medial pterygoid muscles). These muscle parameters were also assessed relative to the vertical craniofacial form and transverse skeletal and dentoalveolar widths.

*Results:* Differences were found in the orientation of the masseter and medial pterygoid muscles amongst growing patients with different underlying vertical facial patterns. Positive correlations were found between muscular size and transverse facial width. Larger maxillary and mandibular intermolar dental widths were also related to orientation of the medial pterygoid muscle. Individuals with larger maxillary widths also tended to have larger masseter muscles.

*Conclusion:* Clinicians should note the potential differences in muscle cross-sectional area, volume and orientation in subjects with different underlying vertical facial patterns and that these in turn are related to

skeletal facial width and even naturally occurring maxillary and mandibular transverse arch dimensions.

This study was supported by the Australian Society of Orthodontists' Foundation for Research and Education Inc.

### **The rate of tooth movement and dentoalveolar stress under heavy and light continuous orthodontic forces studied with a three dimensional finite element model**

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**Tamer Turk**

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*Introduction:* The aim of this study was twofold: to measure the rate and amount of orthodontically induced tooth movement under heavy (300 g) and light (50 g) continuous orthodontic forces using superelastic NiTi closing coils over a defined period of time (12 weeks); and to explore the biomechanical response of the periodontal ligament and maxillary alveolar bone under such forces using a three dimensional finite element model (FEM).

*Methods:* 14 patients who required maxillary canine retraction into first premolar extraction sites as part of their orthodontic treatment completed this study. In a split-mouth design, precalibrated NiTi closing coil springs delivering a force of 300 g and 50 g were used to distalise the canines following an alignment and stabilisation period. Intra-oral and maxillary cast measurements were made at the beginning of canine retraction and every 28 days for 84 days to assess total space closure, canine retraction rate, amount of canine retraction and molar anchorage loss and degree of canine rotation. The finite element model was created from cone beam computed tomography (CBCT) data obtained from one patient, who was deemed representative of the entire sample.

*Results:* The amount of initial tooth movement was not related to force magnitude, however after a period of 28 days, an increased amount and rate of tooth movement with the use of heavy forces was detected. This significantly increased the rate and amount of canine retraction; however the adverse effects of loss of canine rotational control and anchorage loss were concomitantly increased.

*Conclusions:* Light forces provided a greater percentage of canine retraction than heavy forces, with less strain on anchorage. The FEM showed that heavy forces tend to produce greater stress energy than light forces.