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# Literature

## reviews

These literature reviews have been prepared by the orthodontic postgraduate students of the University of Queensland, Brisbane, Australia.

### **Cephalometric comparison of adult anterior open bite treatment using clear aligners and fixed appliances**

**Garnett BS, Mahood K, Nguyen M, Al-Khateeb A, Liu S, Boyd R, Oh H**

*Angle Orthod* 2019; 89: 3-9

**Introduction:** Controlling the vertical dimension in orthodontics can be considered challenging and it is well known that fixed appliances tend to extrude the dentition during treatment. Numerous auxiliaries and appliances to help control the vertical dimension in hyperdivergent patients have been discussed in the literature. With the introduction of Invisalign, and the theory that the presence of material interposed between the posterior teeth can cause intrusion, some clinicians claim that using clear aligner therapy can effectively manage hyperdivergent cases by preventing posterior extrusion.

**Objective:** To examine the effectiveness of clear aligners in controlling the vertical dimension and in correcting anterior open bites by comparing the outcomes of clear aligner therapy to those of fixed appliance therapy in adult patients with hyperdivergent skeletal patterns (mandibular plane angles (MPA) of  $>38^\circ$ ).

**Materials and methods:** This study was retrospective in nature, using patient data from a single clinician's practice who reported to be an expert in both fixed and clear aligner therapy. A total of 597 patients treated with either fixed appliances between 2008 and 2014 or clear aligner therapy between 2011 and 2014 were screened. Patient pretreatment (T1) lateral cephalometric radiographs were initially analysed using a  $38^\circ$  transparent template to visually determine patient mandibular plane angles. Lateral cephalometric films of patients who presented with hyperdivergent profiles ( $<38^\circ$ ) were further

analysed by two examiners who traced the lateral films using Dolphin Imaging. In total, 98 patients (36 fixed appliance and 62 clear aligner) met the inclusion criteria, including consecutively treated hyperdivergent patients with anterior open bites ( $<0$  mm overbite). Any malocclusion type was considered, although the number of patients with anterior open bites was similar between both fixed and clear aligner therapy groups. Various auxiliaries were used to control the vertical dimension in patients treated with fixed appliances including: TADs, transpalatal arches, lower lingual holding arches, lower bite blocks and/or bicuspid extractions. The clear aligner group were all managed by a non-extraction approach with accompanying IPR, arch expansion and the use of optimised attachments. Prior to treatment with either fixed or clear aligner therapy, patients who presented with anterior tongue thrusts (two treated with fixed appliances and seven treated with clear aligner therapy) were prescribed myofunctional exercises for 10 minutes. Post-treatment lateral head films (T2) were digitised using Dolphin Imaging and superimposed on the anterior cranial base of T1 lateral cephalometric films where the Frankfort horizontal and Down's occlusal planes were transferred as reference planes to the T2 lateral head films.

**Results:** The findings concluded that the duration of treatment in hyperdivergent patients is similar for both fixed appliances and clear aligner therapy groups, with comparable post-treatment overbites and mandibular plane angles in patients with moderate to severe anterior open bites. Overall, overbite correction and increase in mandibular plane angle were slightly greater in patients treated with clear aligner therapy but this was not considered to be statistically significant. The only significant difference found when comparing both clear aligner and fixed appliance groups was the vertical dental linear measurements

from the mandibular plane to the lower incisor tip, suggesting that the lower incisors extruded more in the clear aligner group than the fixed appliances group (0.8 mm vs 0.1 mm respectively).

*Conclusions:* Clear aligner therapy appears more successful at extruding the lower incisors than fixed appliances.

Clear aligner therapy can be as effective as fixed appliances in controlling the vertical dimension and correcting anterior open bites in adult hyperdivergent patients without the need for additional auxiliaries.

*Critical appraisal:* This retrospective cohort study consisted of 98 adult patients treated by one clinician and therefore may not represent the general population and external validity of outcomes may be questionable.

Rationale for allocation of patients to the different treatment groups was not given, so selection bias cannot be ruled out.

Digitisation of the lateral cephalometric films of patients included in the study was performed by two examiners, although there was no mention of assessing inter-operator error. Therefore, tracing of the cephalometric radiographs and the included sample population in the study may not be accurate.

The results demonstrated a slightly increased, non-statistically significant difference in mandibular plane angle in the clear aligner group compared to the fixed appliances group, although the difference in angulation was recorded in millimetres instead of degrees.

The participants included in the fixed appliance group were exposed to various mechanics to help control the vertical dimension, with 41% treated with extractions, and therefore they represent a heterogeneous population compared to a homogenous sample of patients treated with clear aligner therapy.

To conclude, this study has provided some evidence that aligner therapy is as successful as fixed appliances in managing hyperdivergent patients and using less complex mechanics. Further research with improved methodology is required to confirm the current findings.

**Haylea Blundell**

## **Comparison of anterior retraction and anchorage control between en-masse retraction and two-step retraction: A randomized prospective clinical trial**

**Schneider PP, Gandini Júnior LG, Monini ADC, Pinto ADS, Kim KB**

*Angle Orthod* 2019; 89: 190-9

*Background and aims:* The closure of extraction spaces can be performed using two main retraction techniques: en-masse retraction (ER) or two-step retraction (TSR). Space closure achieved by ER involves incisors and canine retraction in one step as a group, in comparison with TSR, which involves canine retraction followed by incisor retraction in two steps. Traditionally orthodontists preferred TSR over ER when posterior anchorage control is critical, despite lacking relevant evidence regarding its efficiency. The purpose of this study was to investigate and compare ER and TSR in the maxillary and mandibular arches during orthodontic space closure without usage of auxiliary anchorage devices.

*Methodology:* This prospective RCT involved 48 adult patients with bimaxillary protrusion who were planned for treatment with the extraction of four first premolars, randomly allocated into equal numbered ER (N = 24, Mean age: 23.9 yrs, SD: 3.43 yrs) and TSR (N = 24, Mean age: 22yrs, SD: 4.8 yrs) groups. There were no drop-outs in the study. Pre-retraction (T1) and post-retraction (T2) lateral cephalometric radiographs and oblique cephalometric radiographs at 45 degrees were superimposed on the anatomic best fit of the maxilla and mandible. Horizontal and vertical movements of molars and incisors were assessed using reference planes. The horizontal reference plane was drawn parallel to a functional occlusal plane under the cephalometric landmarks and a vertical reference plane was drawn perpendicular to the horizontal reference plane passing posteriorly to the cephalometric landmarks, above the vertical level of orbit. All readings were taken after superimposition, by a single operator who was blinded. The measurements were made to determine posterior anchorage loss between two groups and additionally to analyse the inclination changes between posterior and anterior teeth. The Student's *t*-test was used to compare the means between the two groups.

*Results:* Maxillary and mandibular molar crown movements showed no significant differences in

horizontal and vertical displacements and in tipping between the ER and TSR groups. Furthermore, there was no difference between left and right side. Maxillary and mandibular incisor crown movements and tipping showed no significant differences between the two groups for the horizontal and vertical displacement. There was no difference noticed between right and left sides. However, the apex of the upper incisor in the ER group showed more displacement (1.98 mm +/- 1.08 mm) in the horizontal direction when compared with the TSR group (1.21 mm +/- 0.87 mm).

*Conclusion:* This trial has shown that en-masse and two stage retraction are both equally effective in achieving space closure without any significant difference in posterior anchorage loss. Magnitudes of incisor and molar tipping were similar between the two space closure methods, with the crowns moving more than the apices.

*Critique:* The method of randomisation is not clearly stated in this study. Sample size was not calculated using a power analysis. Inter-operator variability was not evaluated as the study was conducted by a single operator and so the reproducibility of the study is questionable. The authors did not state the use of any inter-arch elastics during the treatment, which makes the space closure not appropriate as it would not be symmetrical. If the inter-arch elastics were indeed used then it could affect posterior anchorage loss, which was not quantified. However, significant attempts were made to match the sample group characteristics and treatment mechanics. In addition, this trial is one of the few RCTs without any drop-outs in the number of subjects, which reduces the risk of bias and adds to the reliability of the results. Future studies addressing the limitations of this trial may be helpful in furthering an understanding of posterior anchorage loss between two different space closure methods.

**Raj Gaddam**

### **Do orthopedic corrections of growing retrognathic hyperdivergent patients produce stable results?**

**Rice AJ, Carrillo R, Campbell PM, Taylor RW, Buschang PH**

*Angle Orthod* 2019, Feb 11. doi: 10.2319/061818460.1. Epub ahead of print

*Objectives:* To determine if posterior dental intrusion produces stable orthodontic and orthopaedic corrections in growing retrognathic hyperdivergent patients.

*Materials and methods:* The sample included 14 subjects (five males and nine females), who were 13.4 ± 0.7 years pretreatment, treated for 3.5 years, and followed for 3.6 years post-treatment. During the initial orthopaedic phase, 150 g NiTi coil springs were attached to two palatal miniscrew implants (MSIs) for maxillary intrusion while two buccal mandibular MSIs were used for posterior vertical control. Full orthodontic therapy was initiated to correct the malocclusions during the orthodontic phase. The patients were recalled a minimum of one year post-treatment (mean 3.6 ± 1.6 years). Patients were compared with matched untreated controls.

*Results:* Relative to the untreated controls, during treatment and retention, maxillary and mandibular molars underwent 2.8 mm and 3.7 mm of relative posterior intrusion, respectively. Maxillary incisors were extruded 1.3 mm and the mandibular incisors underwent 2.9 mm of relative intrusion. Overall orthopaedic changes included a reduction in the mandibular plane angle (MPA; 3.3°), an increase in SN-Pg (2.4°), an increase in S-N-B (2.1°), and a 4.3 mm relative reduction in anterior facial height. The maxillary incisors, which showed 0.6 mm of intrusion (relative to controls), were the only dental or skeletal measures to show a statistically significant between-group post-treatment difference.

*Conclusions:* Except for maxillary incisor position, the substantial dental intrusion and associated orthopaedic corrections that were produced during treatment remained stable post-treatment.

*Critical appraisal:* This was a prospective study that aimed to determine if the orthodontic and orthopaedic cephalometric improvements, produced with nonsurgical posterior dental intrusion using mini-implants, were stable when performed on growing hyperdivergent retrognathic patients. When considering the population studied, the term 'retrognathic' was not well-defined and information regarding the maxillary position was not mentioned.

The study followed up 14 patients (five males, nine females) with a mean age of 13.4 years (SD = 0.7 years), at a minimum of one year post-treatment (mean 3.6 years, SD = 1.6). Bimaxillary posterior dental intrusion was attempted in growing hyperdivergent Class II patients using mini-implants. The results were then compared to matched untreated controls obtained from another growth study. Although active posterior dental intrusion was minimal, when compared with

the controls, the MPA reduced, SN-Pg improved, and the lower anterior facial height decreased. This emphasises the importance of controlling the vertical dimension in Class II hyperdivergent patients during orthodontic treatment, as most of the improvements in this study were due to maintenance of the vertical position of the posterior teeth. Nevertheless, the sustainability of 'orthopaedic improvements' produced during treatment without the re-establishment of vertical growth pattern can only be elucidated by a long-term follow-up study.

The limitations of this study are four-fold: a small sample size; using matched controls from another study (University of Montreal growth study); not recognising the variations that exist within hyperdivergent phenotypes; and an insufficient length in the duration of the follow-up. Active orthodontic treatment lasted on average for 3.5 years, which would mean that these patients had a long treatment plan with an active retention program commencing soon after. Furthermore, not all growing Class II hyperdivergent phenotypes may benefit from posterior dental intrusion, particularly those hyperdivergent patients without an anterior open bite and excessive gingival display. Finally, vertical facial growth continues later into adulthood, and future studies need to follow up patients longer than a minimum of just one year post-treatment when evaluating the stability of orthodontic improvements in the vertical dimension.

**Arun Shailendran**

### **Cone beam computed tomography devices in the evaluation of buccal bone in anterior teeth**

**Dantas LL, Ferreira PP, Oliveira LS, Neves FS, Campos PSF, Scarfe WC, Crusoe-Rebello I**

*Aust Dent J* 2019, Mar 6. doi: 10.1111/adj.12685. Epub ahead of print

*Introduction:* The authors discuss the importance of assessing the amount of buccal bone present before contemplating anteroposterior orthodontic movement of the incisors. They discuss the limitations inherent with two-dimensional radiography for assessing this bone, with three-dimensional CBCT the preferred imaging modality. However, they question whether the accuracy of visualisation of such thin structures might vary between machines and exposure settings. They therefore sought to investigate the diagnostic

accuracy of different CBCT machines in assessing the amount of labial bone present over anterior teeth.

*Methodology:* The authors conducted an in vitro study, using one dry skull with intact maxillary and mandibular teeth, and wax to simulate the soft tissues. The anterior maxilla and mandible of the skull were imaged with six different CBCT machines – 3D Accuitomo 170, CS 9000 3D, CS 9300, Eagle 3D, i-CAT Classic, and Orthophos XG 3D. The voxel size was adjusted to between 0.16 mm and 0.22 mm.

Two blinded oral radiologists assessed the DICOM datasets to determine the presence or absence of labial bone in the coronal, middle, and apical thirds in each of the 12 anterior teeth. Therefore, 36 'thirds' were assessed per CBCT machine, with 216 root thirds being assessed in total.

The accuracy of radiographic diagnosis was assessed via direct digital calliper assessment of the labial bone of the skull.

*Results:* Overall, all CBCT devices demonstrated high accuracy in detecting loss of labial bone, with no differences between CBCT machines.

*Conclusion:* The authors concluded that all the CBCT units provided 'high diagnostic accuracy in the evaluation of buccal bone'.

The authors acknowledged that varying exposure settings (mA, kVp) and acquisition parameters (scan mode, resolution, FOV) could affect the diagnosis of labial bone loss. However the authors did not/could not standardise these exposure and acquisition parameters, and the six machines varied widely. For example, the Carestream CS 9300 unit had the lowest dose-area product (276 mGy.cm<sup>2</sup>), while the Eagle 3D had the highest (1454.1 mGy.cm<sup>2</sup>). Despite these differences, no differences were found in the diagnostic accuracy of the various CBCT units, and so the authors suggested that the ALARA principle would favour the units demonstrating the lowest radiation exposure.

*Critical analysis:* An early access version of this paper was evaluated as it had undergone full peer review and had been accepted for publication, but had not yet been through the copy-editing, typesetting, pagination, and proofreading process.

While the in vitro nature of the study should be kept in mind, the conclusions of this study are clinically relevant to clinicians and highlight the validity in

CBCT analysis of alveolar dehiscence/fenestration. The study could have been improved via standardisation of exposure settings, and the evaluation of more than one skull; for example, assessing different skulls with thick versus thin alveolar housings, or assessing skulls with differences in bone density. Ultimately, an in vivo investigation would provide the greatest clinical validity.

**Phillip Goh**

### **Reliability of upper airway assessment using CBCT**

**Zimmerman JN, Vora SR, Pliska BT**

*Eur J Orthod* 2019; 41: 101-8

*Aim:* The aim of this study was to determine the intra-examiner and inter-examiner reliability of all essential steps in the volumetric and cross-sectional area assessments of the upper airway, using CBCT imaging.

*Method:* Following a sample size calculation and ethics approval, de-identified CBCT scans of 10 patients were obtained at random from a university database of previously treated cases. The CBCT scans were taken by one operator using the same I-CAT tomographic machine. The images were exported in DICOM format and uploaded into Dolphin Imaging for analysis.

Six health professionals, including an oral and maxillofacial radiologist, an academic orthodontist, an academic orthodontist with additional experience in sleep medicine, a private practice orthodontist, a senior orthodontic resident and a junior orthodontic resident, were orientated, trained and calibrated as examiners for upper pharyngeal airway analysis using CBCT images not included in the study.

The airway analysis was performed using a standardised protocol in which the nasopharyngeal, oropharyngeal, hypopharyngeal and total upper pharyngeal airway volumes were measured. The examiners independently and manually orientated the patient 3D image in the coronal, sagittal and transverse planes, before selecting the slice in the mid-sagittal plane for tracing. In addition, a selected threshold sensitivity value was set to discriminate soft tissue from air space, and a minimum cross-sectional area calculated.

The measurements were repeated after four weeks and intra- and inter-examiner reliability was calculated

using ICC and 95% CI. Reliability was ranked according to the ICC value and considered excellent when the score was above 0.9, good when it was between 0.76 and 0.9, moderate when it was between 0.5 and 0.75 and poor when it was below 0.5.

*Results:* The selection of the threshold sensitivity value showed poor intra-examiner (mean ICC 0.473) and poor inter-examiner (ICC 0.100; CI 0.000–0.380) reliability. Minimum cross-sectional area showed moderate intra-examiner (mean ICC 0.591) and poor inter-examiner (ICC 0.223; CI 0.029–0.581) reliability. Total airway volume showed good intra-examiner (mean ICC 0.819) and poor inter-examiner (ICC 0.175; CI 0.000–0.533) reliability. Nasopharyngeal airway volume showed good intra-examiner (mean ICC 0.777) and poor inter-examiner (ICC 0.350; CI 0.124–0.690) reliability. Oropharyngeal airway volume showed excellent intra-examiner (mean ICC 0.976) and excellent inter-examiner (ICC 0.945; CI 0.849–0.985) reliability. Lastly, hypopharyngeal airway volume showed moderate intra-examiner (mean ICC 0.747) and moderate inter-examiner (ICC 0.550; CI 0.297–0.822) reliability. Additionally, the reliability of the examiner varied with education and experience, with those more educated and experienced having higher ICC values.

*Conclusions:* The selection of the threshold sensitivity value generally had poor reliability. The oropharyngeal volume was the only variable examined that had excellent intra- and inter-examiner reliability. With operator experience, reliability tended to improve. Further studies are needed before CBCT can be advocated for valid and reliable comparison of upper airway dimensions.

*Appraisal:* This study was well executed and relevant to contemporary orthodontic practice and research. A sample size analysis was carried out and appropriate inclusion and exclusion criteria applied. The examiners did not have access to their previous assessments at the time of the second analysis, and the scans were randomly analysed to allow for a blinded assessment.

The methodology was sound in the respect that this study required the examiners to manually orientate and select the mid-sagittal plane slice of the CBCT images and further select the threshold sensitivity value. Other studies have failed to do this despite the procedures being highly subjective and having the potential to reduce reliability of airway measurements

using three-dimensional software analysis.

The authors note that reliability tended to improve with operator experience. However, the different levels of education and experience were only represented by one operator each, so this conclusion should be interpreted with caution and further studies with larger sample sizes and assessors could be considered.

A primary confounding factor related to CBCT studies that assess the airway is head, body and jaw position at the time of scan acquisition. When the airway is measured in an upright and awake position, the scan may have no correlation with how the airway functions when a person is supine and sleeping. As airway analysis is often undertaken under suspicion of sleep apnoea, this is an important consideration. Therefore, the results of this paper should also be considered in light of the recent findings published in the American Association of Orthodontics white paper on sleep apnoea, which asserts that 2D and 3D images do not currently provide a proper risk assessment technique or screening method for this condition.

**Chris Costello**

### **Corrigendum: Does low-frequency vibration have an effect on aligner treatment? A single-centre, randomized controlled trial**

**Lombardo L, Arreghini A, Ghislanzoni LTH, Siciliani G**

*Eur J Orthod* 2019, Jan 11. doi: 10.1093/ejocjy084. Epub ahead of print

**Aim:** To determine differences in the accuracy of tooth movements in patients treated with aligners, compared with a conventional protocol, employing low frequency vibration and/or reducing the aligner change interval.

**Design:** The study was a prospective, three arm, parallel-group, single-centre, randomised controlled clinical trial conducted at the University of Ferrara, Post Graduate School of Orthodontics.

**Randomisation:** Computer generated randomisation allocated participants into one of three groups: (A) Aligners replaced every 14 days (conventional), (B) Conventional + 20-minute vibration/day (C) 7-day aligner change + 20-minute vibration / day.

**Blinding:** Patients and clinicians were not blinded. The single operator who assessed the digital models, and the operator who performed the set up were blinded.

**Methods:** Forty-five adult patients (20 males, 25 females) aged  $27.1 \pm 9$  years requiring orthodontic treatment with F22 aligners for correction of dental alignment were recruited and randomly allocated to the three groups. F 22 attachments and IPR (max. 2 mm) were used, without further auxiliaries.

Pretreatment and post-treatment digital models were assessed for accuracy of tooth movements with VAM software. One hundred anatomical points identified by the operator were converted into 3D coordinates and exported onto an Excel spreadsheet for extrapolation of mesio-distal tip, labiolingual tip and rotation. The occlusal plane was used as a reference. Mean prescription and mean imprecision for tooth movements were reported.

$$\text{Accuracy} = 1 - \frac{\text{Ideal Outcome} - \text{Post-treatment Outcome}}{\text{Ideal Outcome} - \text{Pre-treatment}}$$

which correspond to

$$\text{Accuracy} = 1 - \frac{\text{Imprecision}}{\text{Prescription}}$$

**Results:** Fifteen patients in each group (45 total) were analysed. No drop-outs occurred. Compliance with the 20-minute recommended use of the vibration device (with built-in timer) was recorded for Group B (conventional + 20-minute vibration/day) and C (7-day aligner change + 20-minute vibration / day). Both groups averaged below the recommended compliance times. In the upper arch, no significant differences were observed between Group A (conventional) and C nor between A, B or C in the lower arch. Upper incisor rotation in Group B was significantly more accurate ( $P = .016$ ) when compared with Group A. Labiolingual tipping ( $P = .007$ ) and mesiodistal tipping ( $P = .029$ ) was more accurate in Group B than Group C. The upper molar labiolingual tip ( $P = .001$ ) was more accurate in Group B when compared to Group C.

**Conclusions:** The study reported mean total imprecision for all tooth movements was  $2.1^\circ \pm 0.9^\circ$ , with a mean prescription of  $5.7^\circ \pm 2.2^\circ$ . There was no statistically significant difference in the accuracy of tooth movement when comparing 7-day aligner wear with vibration and 14-day aligner wear without vibration. The addition of vibration to the conventional protocol was reported to increase the accuracy of upper incisor rotation by 10%. The conventional protocol with vibration improved the tipping (mesio-buccal and

buccolingual) of the upper canines and buccolingual tip of the upper molars between 13–16%, when compared with the 7-day protocol with vibration.

*Critique:* The study was initially published in the EJO in November 2018 and entitled ‘Accelerating aligner treatment using low-frequency vibration: a single-centre, randomized controlled clinical trial’. A corrigendum was released in January 2019. The study was revised with corrections, including a change in title. The authors noted the following limitations of the study:

- Trial registration was obtained retrospectively, which introduces bias.
- The occlusal plane was used as a reference, which is subject to change and therefore is not stable.
- A control 7-day change group without vibration may be worth comparing.
- The direction of tooth movement was not taken into consideration.

Although a previous RCT included a control group with a deactivated vibration device, Group A in this study did not. It was justified by the authors that a ‘sham’ appliance would generate a seating force on the aligners and therefore nullify the significance of a control group.

The study mentioned that the treating clinician and patients were not blinded, which may introduce a ‘placebo effect’. Furthermore, co-interventions were provided to Group B and C for motivation on the use of vibration device. Inter-observer reliability was not reported, and the paper is at risk of sponsorship bias.

A strength of the study was that all participants were accounted for and no drop-outs occurred.

*Summary:* Low-frequency vibration seemed to improve the accuracy of tooth movement, using the aligner conventional protocol. The translation of statistical significance to clinical significance remains to be determined. Although these results seem impressive, the limitations of the study should be considered before application to clinical practice.

**Ameesha Maree**

## **Is Short Root Anomaly (SRA) a risk factor for increased external apical root resorption in orthodontic patients? A retrospective case control study using cone beam computerized tomography**

**Cutrera A, Allareddy V, Azami N, Nanda R, Uribe F**

*Orthod Craniofac Res* 2019; 22: 32-7

*Background:* Short Root Anomaly (SRA) was first described in 1972, as a condition in which the maxillary central incisors and premolars have normal coronal morphology, but abnormally short roots with rounded apices. Typically the root to crown (R/C) ratios are reduced ( $\leq 1.1$ ). Later studies have shown that other teeth can be affected as well. A characteristic feature of SRA is its strong bilateral occurrence. The aetiology is poorly understood, although there is evidence of SRA having a genetic component that affects the mechanisms of root formation. The overall prevalence ranges from 0.6% to 2.4%, with higher prevalence rates of up to 10% in Japanese and Mongolian populations. It is believed that teeth affected with SRA have an increased risk of root resorption during orthodontic treatment. However, to date, no studies have attempted to determine the risk of root resorption in an orthodontically-treated SRA sample using CBCT data.

*Aims:* To evaluate the amount of external apical root resorption (EARR) after orthodontic treatment in patients with SRA compared with a control group with normal maxillary incisor root lengths using CBCT scans. The secondary aim was to explore the influence of gender, age and treatment duration on the root resorption process in these patients.

*Methods:* Pre- and post-treatment CBCT scans of 23 SRA and 26 control patients were selected from a single private practice. All were treated by the same practitioner between 2011 and 2014. The scans were acquired using the same machine and exposure parameters, and were retrospectively screened for inclusion by a single examiner.

This study examined maxillary central and lateral incisors only. In the SRA group, R/C ratios were  $\leq 1.1$  for both central incisors as measured on the pretreatment CBCT scan, and there was otherwise normal crown and root morphology. In the control group, the average R/C ratios were 1.3 for the central and 1.4 for the lateral incisors.

In both groups, eligible patients were excluded if they were taking medications that could affect root development, had previous orthodontic treatment, a history of dentoalveolar trauma, metallic restorations or endodontic treatment of the maxillary incisors, impacted canines in contact with the apex of any of these teeth or evidence of existing root resorption.

Linear measurements of crown and root lengths were made in millimetres in the sagittal view, with the reconstructions oriented perpendicular to the long axis of each of the incisors. Pre- and post-treatment measurements were compared for differences in the change in tooth and root length of the maxillary incisors between the two groups.

*Results:* The mean values for all measurements decreased by 0.6–1.3 mm after orthodontic treatment, suggesting a slight amount of root resorption in both groups. There was no significant difference between the groups for the majority of the measurements, although there was a trend for less EARR in the SRA group. Only tooth length for the left central incisor had significantly less total tooth loss than the controls when considering tooth length changes independently and in proportion to pretreatment lengths.

The mean age of the sample was approximately 21 years, and the mean treatment time for both groups approximately 20 months ( $20.7 \pm 5.2$  for the SRA and  $19.2 \pm 5.3$  for the control groups). Age, gender and treatment duration were not associated with more

root resorption in the SRA group compared with the control group.

*Conclusions:* This retrospective study demonstrated that SRA-affected maxillary incisors were no more susceptible to EARR during orthodontic treatment when compared to the controls without this anomaly. Orthodontic movement of teeth with SRA does not appear to be contraindicated, although authors advise careful monitoring of SRA patients with four- to six-monthly periapical radiographs.

*Critique:* The authors acknowledge and discuss several limitations of this study. The primary limitation is its retrospective nature. The sample was derived from a single practitioner, limiting the generalisability of the results. No details regarding the presenting malocclusion, treatment provided, mechanics or the magnitude and type of root movement were collected or analysed. It was stated that intra-examiner reliability, determined by double measurements, was high for all variables, although there was no sample size calculation. Root resorption was assessed using linear measurements rather than volumetric quantification. The diagnostic criteria for short-rooted teeth vary. To accurately diagnose this anomaly, there is a need to establish reference data for average R/C ratios in unaffected individuals in different populations based on CBCTs.

**Borjana Simanovic**