
Literature

reviews

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

Morphology of palatally impacted canines: A case-controlled cone-beam volumetric tomography study

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Background: Impacted maxillary canines are relatively common in orthodontic practice. There are guidance and genetic theories associated with their aetiology, and they are often associated with anomalous lateral incisors. While the morphology of lateral incisors has been well investigated, little has been published on the morphology of palatally-impacted canines.

Aim: To investigate whether there is a higher prevalence of severe apical curvature/hook, other lesser root curvatures, and the crown:root ratio in subjects with palatally-impacted maxillary canines, compared to non-impacted canines

Materials and methods: A retrospective investigation of 44 subjects, with a total of 59 palatally-impacted canines, who had been referred to a radiology practice for CBCT imaging. Subjects were 10 to 16 years old and were not included if there was canine transposition, canines with open apices, blurred images, or if they were undergoing orthodontic treatment. If there were bilaterally impacted canines, only one was randomly selected for analysis, yielding a total of 44 impacted canines. A control group of age- and gender-matched individuals with normal canines was selected, yielding a comparison group of 98 canines from 49 individuals. The investigators assessed the degree (and direction) of curvature of the apical tip of the canine to its long axis, the lengths of the crown and root, the mesio-distal position of the cusp tip, vertical position of the cusp tip, and angulation of the canines relative to the mid-sagittal plane.

Results: The investigators found that 36.4% of the palatally-impacted canines had an apical hook, with a further 11.4% having a less severe curvature. If a hook was present, this was almost exclusively (93.8%) in a mesial direction. In comparison, only 1% of non-impacted canines had a hook, and a further 26.5% had a less severe curvature. It was uncommon to find any hooks or curvatures in a labial or palatal direction. The crown:root ratio also differed between impacted and non-impacted canines – the root length was shorter for palatally-impacted canines, and they also had a marginally longer crown. There was no relationship found between the presence of a hook, and the mesio-distal position of the canine cusp tip, vertical position of the cusp tip, and the angulation of the palatally-impacted canine to the mid-sagittal plane.

Conclusions: Palatally-impacted canines are morphologically dissimilar to non-impacted canines, exhibiting greater dilaceration of the apical tip, and having a larger crown:root ratio (shorter root) compared with non-impacted canines. This appears to be independent of the position of the impacted canine. However, it must be remembered that this sample of palatally-impacted canines was selected by practitioners for further three-dimensional radiographic investigation, and may therefore be more severely impacted or otherwise abnormal to warrant further assessment. Additional studies should validate this finding in a broader sample of impacted canines, and investigate the clinical relevance of this apical hook and increased crown:root ratio.

Phillip Goh

Extraction of maxillary canines: Esthetic perceptions of patient smiles among dental professionals and laypeople

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Background: In the current landscape of evidence-based dentistry in orthodontics, the decision to extract maxillary permanent canines may place the clinician in a quandary. For example, the familiar scenario of an ectopically displaced canine in which the premolar has completely replaced it in the arch warrants consideration for either extraction of the canine as a simple approach, or the heroic measure of premolar extraction and re-alignment of the canine. In the clinician's quandary lie some claims and concepts that need to be weighed against supporting evidence. These may include: (1) canine-guided occlusion provides optimal occlusion (scarce evidence), (2) lack of canine-guided occlusion will predispose the patient to temporomandibular disorders (scarce evidence), and (3) canines are extremely important for aesthetic appearance (scarce evidence).

To date, most claims related to the importance of maxillary canines and their philosophical 'sanctity' are supported by expert opinion and clinician-based reports. Regarding maxillary canine extractions as part of orthodontic treatment, no studies have been undertaken reporting on the aesthetic importance of canines and how laypeople perceive smiles in these circumstances. This is particularly important as aesthetics are the primary reason for patients seeking orthodontic treatment. The present study was conducted to investigate whether there was any difference in the perceptions of patient's smiles by laypeople, dentists and orthodontists based on treatment by extraction of either maxillary canines or premolars.

Materials and methods: A retrospective study was undertaken of 48 patients treated at the Chesterfield Royal Hospital in the United Kingdom from the previous two decades. The inclusion criteria for the treatment group (N = 24) was unilateral or bilateral extraction of maxillary permanent canines and subsequent treatment with fixed appliances in both arches. These were matched with patients who had unilateral or bilateral extraction of maxillary first premolars followed by fixed appliances and treated to an extremely high standard of finish. These patients

had PAR scores less than 5 at the end of treatment. Exclusion criteria were patients who failed to complete a full course of comprehensive care, patients with single-arch treatment only, and patients with syndromes. No patient received cosmetic restorative work.

End of treatment frontal intraoral and extra-oral photographs were standardised with computer software (Adobe Photoshop CC version 14.0, Adobe Systems, CA, USA) for image size and brightness adjustments. The photographs were assigned a random number, blinded to extraction treatment and compiled into a PDF document by the lead author.

A rating panel of assessors was selected and comprised of 10 orthodontists, 10 dentists and 10 laypeople. All laypersons were adult volunteers from the Chesterfield Royal Hospital. A reliability assessment was undertaken by four members from each group. Four weeks later, all 30 assessors were asked to rate the photographs according to the attractiveness of the smile based on a 10-point Likert scale. High scores indicated an unattractive smile. Reliability testing was undertaken using a paired *t* test and intraclass correlation coefficients (ICC). One way analysis of variance (ANOVA) was used to compare group scores ($p \leq 0.05$).

Results and discussion: Forty-eight patients (16 male, 32 female) were assessed. The treatment group consisted of 14 unilateral and 10 bilateral maxillary canine extraction cases.

The level of agreement between the 12 initial assessors' first and repeat assessments was substantial, where ICC was 0.728 (mean difference of 0.25, SD = 1.28, 95% CI: -1.06 to 0.56, $p = 0.515$).

For the main study, attractiveness ratings were not statistically significantly different between the two treatment groups (canine versus premolar: mean difference of 0.33, SE = 0.29, 95% CI: -0.26 to 0.98, $p = 0.268$). The results of the one-way ANOVA repeated measures revealed no differences between orthodontists, dentists and laypeople scores (*Wilks* $\Lambda = 0.835$, $F(92, 22) = 2.17$, $p = 0.138$). Bonferroni correction revealed no statistically significant pairwise differences between assessors. Although not statistically significant, laypeople scored attractiveness slightly higher than orthodontists and dentists.

The likely alteration of canine extractions on golden proportions did not impact overall smile attractiveness

in this study. It was interesting that, despite previous research showing orthodontists' rigorous detection of gingival heights on digitally altered images of canines, the orthodontists in this study did not rate the canine extraction cases different to the premolar cases. This may be attributed to sample size.

A major limitation of the study was the lack of power calculation due to the limited availability of patients treated with canine extractions. Also, this study did not assess unilateral versus bilateral extraction scores. Furthermore, using three-quarters smile photographs could have potentially altered assessors' perceptions. Lastly, functional benefits of canines were not studied. None of the canine extraction patients presented after the completion of treatment with complaints regarding occlusal problems or temporomandibular joint dysfunction. No effort was made to contact these patients.

Conclusion: This study provides evidence that no major aesthetic benefit arises from aligning maxillary permanent canines subsequent to premolar extraction when compared to retention of premolars and extraction of the canines.

Christopher S. Franco

Long-term stability of Class II treatment with the Jasper jumper appliance

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Background and aims: Early intervention in patients with active growth using a combination of functional and fixed appliances can generate desirable outcomes in the treatment of Class II malocclusion. The Jasper jumper appliance in combination with fixed appliance is known to produce a beneficial outcome by promoting light and continuous force, 24 hours a day through mandibular advancement. The aim of the study was to evaluate long-term stability of the changes obtained in the correction of Class II division 1 malocclusion with the Jasper jumper associated with fixed orthodontic appliances, over a period of five years.

Methodology: Twenty-four Class II division 1 malocclusion patients (Mean age – 12.46 years, SD – 1.18) who were evaluated at three stages

– pretreatment, immediate post-treatment, and long term post-treatment – through cephalometric assessment comprised the treatment group, while the control group consisted of 15 subjects (Mean age – 14.05 years, SD – 1.01) with a normal occlusion. A cephalometric assessment of eight angular and 17 linear measurements was analysed using Dolphin software. Intra-treatment group comparisons between the three stages were performed with repeated measures analysis of variance, followed by Tukey tests. Inter-group comparisons of post-treatment changes and normal growth changes of the treatment group were performed using *t*-tests.

Results: A reduction of maxillary protrusion and a significant increase in mandibular effective length in the treatment group was found to remain stable during the post-treatment period. The treatment group showed that the mandibular length continued to significantly increase in the post-treatment period, but at a significantly smaller rate compared with the control group. In comparison with the control group, the inter-arch relationship in the treatment group remained stable with no significant changes in the post-treatment period. This was despite a Wits appraisal showing a significant but slight relapse of the apical base.

The lower anterior facial height displayed a significant increase during both treatment and post-treatment periods. The dental effects of maxillary incisor retroclination and mandibular incisor proclination remained stable with slight relapse in the post-treatment period. Significant vertical dentoalveolar developments of the incisors and molars in the treatment and post-treatment periods were similar to normal growth in the control group. Overjet demonstrated a significant relapse tendency in the treatment group compared with the control group.

Conclusions: Most of the dentoalveolar treatment changes in the treatment group remained stable in the post-treatment period. In contrast, the apical base relationship, maxillary incisor anteroposterior position, and overjet demonstrated significant relapse in the treatment group, warranting an increase in the active retention period.

Raj Gaddam

Effect of supplemental vibration on orthodontic treatment with aligners: A randomized trial

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Introduction: Traditionally Invisalign aligners are changed every two weeks. Adjunctive vibration has been described to accelerate tooth movement and diminish pain symptoms during orthodontic treatment. The aim of this multi-centre, randomised clinical trial was to determine the effects of AcceleDent Aura (OrthoAccel Technologies, Inc. TX, USA) on a one week regimen of Invisalign treatment.

Methods and materials: Adult patients receiving aligner treatment were randomly assigned to experimental Group A (active device) or Group B (assumed device) in a 1:1 ratio. A one week regimen was adopted, by the use of supplemental vibration for 20 minutes a day. Subjects were reassessed for the fit of aligners every three weeks. Compliance, completion of one week regimen, pain, anterior teeth alignment and oral health related QoL outcomes were evaluated. Subjects, assessors and investigators were blinded to the two groups.

Results: Twenty-seven adult patients were randomly allocated to experimental groups A and B. One participant discontinued. Thirteen subjects were assessed in each group. Fisher's exact test measured successful completion of the initial one-week treatment regimen between the two groups. Completion rates, compliance, end of treatment incisor irregularity index, quality of life outcomes and changes between the groups were not statistically significant. Pain was only reduced in Group A on day 3 of the first set of aligners. No harm was reported.

Discussion: The use of supplemental vibration to increase aligner completion has no beneficial effect. The author attributed the high completion rate achieved to the one-week regimen.

Conclusion: AcceleDent Aura had no effect on end of treatment alignment, completion rate of a series of aligners or oral health related quality of life outcome when used with Invisalign. The effect on reducing pain levels was insignificant.

Amesha Maree

How accurate is Invisalign in nonextraction cases? Are predicted tooth positions achieved?

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Angle Orthod 2017; 87: 809-15

Objective: To evaluate the accuracy of Invisalign technology in achieving predicted tooth positions with respect to tooth type and direction of tooth movement.

Materials and methods: The post-treatment models of 30 patients who had non-extraction Invisalign treatment were digitally superimposed on their corresponding virtual treatment plan models using best-fit surface-based registration. The differences between actual treatment outcome and predicted outcome were computed and tested for statistical significance for each tooth type in mesial-distal, facial-lingual, and occlusal-gingival directions, as well as for tip, torque, and rotation. Differences larger than 0.5 mm for linear measurements and 2° for angular measurements were considered clinically relevant.

Results: Statistically significant differences ($p < 0.05$) between predicted and achieved tooth positions were found for all teeth except maxillary lateral incisors, canines, and first premolars. In general, anterior teeth were positioned more occlusally than predicted, rotation of rounded teeth was incomplete, and movement of posterior teeth in all dimensions was not fully achieved. However, except for excess post-treatment facial crown torque of maxillary second molars, these differences were not large enough to be clinically relevant.

Conclusions: Although Invisalign is generally able to achieve predicted tooth positions with high accuracy in non-extraction cases, some of the achieved outcomes may differ from the predicted outcomes. Knowledge of dimensions in which the final tooth position is less consistent with the predicted position enables clinicians to build necessary compensations into the virtual treatment plan.

Critical appraisal: This was a retrospective cohort study investigating the efficacy of Invisalign therapy to achieve the predicted tooth positions in non-extraction cases.

A total of 30 consecutive patients (13 male, 17 female; age 21.6 9.8 years) were selected and treated in a university setting. The participants may not reflect the general population. Also, the patients' orthodontic

treatment was planned and supervised by qualified specialist orthodontists. Hence, the outcomes may not be generalisable (*external validity*).

The post-treatment models of 30 patients who had non-extraction Invisalign treatment were digitally superimposed on their corresponding virtual treatment plan models using best-fit surface-based registration. However, the post-treatment digital models were obtained by taking alginate impressions and were poured into plaster casts, which were then digitised using an orthodontic model scanner. Every step would possibly induce an error, which could then have affected the final results. Though the authors acknowledge this as a potential source of error in the discussion section, the results should be interpreted with caution.

Furthermore, a single operator placed a reference coordinate system with the origin of the axes at each tooth's approximate centre of resistance on the post-treatment model. Choosing an estimated centre of resistance for every tooth (8 mm apical to the cemento-enamel junction for all teeth), along with placing a point in a 3D environment as a reference to coordinate the post-treatment models with virtual treatment models, could have introduced some errors during superimposition.

The authors used the American Board of Orthodontics (ABO) model grading system for case assessment to evaluate the differences between actual treatment outcome and predicted outcome. The results showed that the anterior teeth were positioned more occlusally than predicted, rotation of rounded teeth was incomplete, and movement of posterior teeth in all dimensions was not fully achieved (*statistically significant*). Nevertheless, they used two one-sided *t*-tests (mean differences that fell within -0.5 mm to +0.5 mm for linear measurements and within -2° to +2° for angular measurements were considered equivalent) to assess whether the differences between the predicted and achieved tooth positions were meaningful enough to be clinically relevant. According to the authors, the only clinically significant finding was for the difference in maxillary second molar torque between predicted and achieved position.

To conclude, this was a well written paper and has provided some evidence that Invisalign therapy, although not accurate in predicting tooth movements precisely, may produce a clinically acceptable result in non-extraction orthodontic treatment.

Furthermore, the research finding also reiterates the need for clinicians to modify attachments and build overcorrections into their virtual treatment plans.

Arun Shailendran

Bonded versus vacuum-formed retainers: a randomized controlled trial. Part 1: stability, retainer survival, and patient satisfaction outcomes after 12 months

Forde K, Storey M, Littlewood SJ, Scott P, Luther F and Kang J

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Introduction: This study attempts to shed light on the question of the effectiveness of retention modalities, specifically comparing upper and lower vacuum formed retainers (VFRs) with upper and lower bonded retainers (BRs). In Part 1 of the paper, the primary outcome measured was stability, and secondary outcomes included survival rates and patient satisfaction.

Methods: Designed as a prospective two-arm parallel group randomised controlled trial, the study recruited 60 participants, half of whom were provided with BRs (15 male, 15 female), and the other half with VFRs (12 male, 18 female). Stability measurements were assessed from digitised study models and survivability based on clinical assessment, whereas patient satisfaction was determined based on a questionnaire. The participants were reviewed at four different time points; T0 – at debond, T1 – three months post-debond, T2 – six months post-debond and T3 – 12 months post-debond.

Results: Post-treatment occlusal changes at 12 months suggested no significant difference between the retainer groups in the maxilla. However, occlusal changes tended to be greater in the VFR group in the mandible (LII were 0.77 mm for BR and 1.69 mm for VFR, $p = 0.008$). Regarding the retainer survivability, there were no statistical differences between the two groups in the maxilla (BR: 63.3% & VFR: 73.3%). However, significant statistical difference was noted for the lower retainers (BR: 50% & 80%). Lastly, patient satisfaction responses revealed that VFRs were more uncomfortable and likely to affect their speech compared to BRs, although they were easier to maintain and clean.

Conclusion: There appears to be no evidence of difference in the occlusal changes and survivability

between the two retainer types in the maxilla. However, mandibular BRs were more effective at reducing post-treatment changes in the labial alignment, although they were more likely to fail. Patients felt the BRs were more comfortable and caused fewer speech interferences, but harder to clean than VFRs.

Critical appraisal: Currently, there are limited high-quality published studies that consider the method of retention and, as a result, there is no consensus on the type, appliance and appropriate method. There has been a push for future research in this area, a well-designed prospective randomised controlled trial, which this study has delivered.

This controlled trial was well designed, with the appropriate methodology to answer the research question about the differences between the most commonly used retainers: the VFRs and BRs. The study design included randomisation, appropriate blinding protocols and calibrated measurements with reported high reliability. Despite the participants being recruited from three different centres, all the retainers were placed and reviewed by two orthodontic registrars, thus minimising outcome variability due to operator experience. Similarly, the design and materials of the VFRs and BRs were standardised to ensure the minimisation of confounding factors.

Nonetheless, the inherent issue with any removable appliance is patient compliance. This study did not specifically investigate the issue of compliance in the use of VFRs. It can be said that an assumption of the performance of VFRs has been made by labelling the varying compliance to be a 'real-world' clinical situation. Despite this, other factors such as the operator's communication, reinforcement and method of instruction need to be considered, as these may play a role in patients' compliance and thus post-treatment stability.

The primary outcome measuring stability revolved around Little's irregularity index, intercanine width, intermolar width, arch length, overjet and overbite. These basic measures of relapse have a strong focus on labial alignment. Thus, many may criticise the study for only looking at the basic post-treatment changes. It would have been beneficial to extend the scope to perhaps consider cephalometric variables. Nonetheless, especially considering a patient's point of view, the maintenance of alignment should perhaps

remain as the principal measure of success in retention.

The study investigated the initial 12 months of retention post-debond and this would be considered a relatively short follow-up to illustrate long-term outcomes. While speculation can be made about the effectiveness of VFRs and BRs beyond this period, clinicians need to tread carefully with the extrapolation of these findings. Compliance of patients is likely to be higher in the earlier stages of retention and, hence, a longer period of investigation may indeed yield a different result.

Overall, this well-designed randomised controlled trial has provided great insight and useful data to further the debate between VFRs and BRs. This study would undoubtedly be a useful reference to reflect on one's clinical practice and retention protocols.

Sigid Fu

The use of panoramic radiographs to decide when interceptive extraction is beneficial in children with palatally displaced canines based on a randomized clinical trial

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Introduction: As orthodontic treatment requires significant resources related to finance, clinical skills and, importantly, patient compliance, possible interceptive treatment that reduces treatment time is important to consider. Palatally-displaced canines (PDCs) often require surgical exposure and traction, which invariably leads to a lengthy treatment time. The extraction of a deciduous canine can act as a successful interceptive treatment for PDCs, but does not always generate the permanent successor's appropriate eruption pathway.

The aim of this randomised control trial was to evaluate possible predictors for successful eruption of a PDC after extraction of the deciduous canine via the use of panoramic radiographs (PAN).

Materials and methods: The RCT took place over two years and four months (September 2008 to January 2011) in 15 public dental clinics in Gothenburg, Sweden. For patients to be included, they were required to have either maxillary unilateral or bilateral PDCs diagnosed clinically and radiographically. Additionally, the patients had to have no history of

orthodontic treatment, retained deciduous canines and be aged 10–13 years. Patients were excluded if over 2 mm of crowding was exhibited in the maxillary arch.

There were two groups: an extraction of the deciduous canine group (EG) and a control group (CG) with no extraction. Patients were randomly assigned into the two groups with a 1:1 ratio. Patients with bilateral retained deciduous canines were then allocated either the right or left canine for extraction.

The method depicted by Ericson and Kurol was used for assessing the alpha angle and sector of the PDC on the panoramic radiograph. Successful and unsuccessful outcomes were measured by logistic regression models developed by the authors.

Results: Sixty-seven patients participated, 22 of whom had bilateral PDCs and 45 had a unilateral PDC. There was no statistically significant difference between left and right extraction sides for those with bilateral PDCs.

For the CG, spontaneous eruption was successful in those canines which had a significantly smaller alpha angle ($\leq 20^\circ$) in sector 2. Of the canines that did not erupt either in the EG or CG, the PDCs were positioned in a higher sector (4 or 5), there was more advanced root development and a larger alpha angle ($\geq 30^\circ$) and the children were older. The predictors for successful eruption of a PDC in the EG were an alpha angle between $20\text{--}30^\circ$ and the PDC in sector 2–3.

Other observations were made with eight children requiring surgical intervention to expose the PDC. A midline shift was observed in six of 35 children in the EG. A degree of rotation/drift of adjacent teeth into the extraction space occurred in 37% of the patients six months after the extraction of deciduous canine.

Discussion: If subjecting a patient to a potentially traumatic clinical procedure such as an extraction, it is imperative to consider the risks versus benefits. This study proposes that certain criteria can be used to determine if extraction of a deciduous canine can aid in the successful eruption of a PDC. These criteria – the alpha angle, PDC root development and sector measurements – are able to be determined from a panoramic radiograph rather than cone beam computed tomography. Clinically this is important as a panoramic radiograph is a resource to which more clinicians have access.

It needs to be reiterated that, although the findings in this RCT were significant, the patients recruited for this study had minimal crowding in the maxillary arch.

Natasha Clare

Orthodontics with Customized versus Noncustomized Appliances: A Randomized Controlled Clinical Trial

Penning EW, Peerlings RHJ, Govers JDM, Rischen RJ, Zinad K, Bronkhorst EM, Breuning KH and Kuijpers-Jagtman AM

J Dent Res 2017; 96: 1498-1504

Background: Insignia (ORMCO Corporation) is a comprehensive orthodontic treatment package incorporating digital diagnostics, three-dimensional (3D) digital planning, and computer-designed customised brackets and archwires. This package enables the orthodontist to digitally plan the treatment and the company manufactures a 3D digital setup, calculates the optimal bracket position, and manufactures individualised brackets and archwires. It has been suggested that, theoretically, the customised treatment systems offer significant advantages to the patient and practitioner, including reduced chair time and shorter treatment duration.

Aim: This randomised controlled trial aimed to compare the duration of orthodontic treatment with a customised versus non-customised orthodontic system. The null hypothesis was that the customised appliance system was not associated with significantly shorter treatment duration compared with a non-customised appliance.

Materials and methods: Eligible patients were randomly assigned treatment with either fully customised self-ligating brackets or non-customised self-ligating brackets. Eligibility criteria included: 12 – 30 years of age and scheduled to receive fixed appliance therapy for the treatment of Angle's Cl I, II or III malocclusions.

Treatment was completed by two equally experienced practitioners and followed the usual procedure of diagnosis, treatment planning, treatment and retention. The primary outcome recorded was treatment duration. Other outcomes recorded were the level of improvement using the Peer Assessment Rating, number of visits, number of loose brackets,

time required for treatment planning and number of complaints.

Whilst blinding the patient and practitioner to the treatment group was not possible, there was randomisation of group allocation and the researcher assessing the outcomes was blinded to the treatment groups.

Results: It was found that, whilst the treatment durations were dependent on the orthodontist, there was no significant difference between the treatment systems. Also, there was no significant difference between the two systems with respect to the quality of the outcome as measured by the PAR improvement. The customised group did record significantly higher numbers of loose brackets and complaints, as well as requiring more time treatment planning relative to the non-customised group.

Conclusions: There was no evidence to reject the null hypothesis. The treatment duration and quality was dependent on the pretreatment condition and the treating orthodontist rather than the system used for treatment. The customised appliances were associated with increased treatment planning time and increased number of loose brackets.

Vanessa Brown

The effect of conventional versus figure-of-eight module ligation on mandibular incisor alignment: a randomised controlled trial

Little RA and Spary DJ

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Introduction: Orthodontic tooth movement can be hindered by the generation of friction. The use of ligatures on brackets has been known to increase friction on an archwire. The consensus is that the use of the figure-of-eight ligature technique produces more friction on an archwire compared with the conventional ligature and the stainless-steel ligation methods.

Aim: The aims of this study were to determine whether using figure-of-eight modules affects the rate of lower incisor alignment compared with conventionally configured modules and to establish whether there are any differences in the number of bracket failures between the conventional and figure-of-eight module groups.

Materials and methods: One hundred and twenty patients from the Orthodontic Department at the Queens Hospital, Burton, UK, participated in a randomised controlled trial in which conventional and figure-of-eight modules were compared in alignment of lower anterior crowding and bracket failure. The patients were equally divided into two groups: one group exposed to the conventional ligature modules and the other group to the figure-of-eight method. Extraction and non-extraction patients were stratified, dividing both module techniques further into premolar extraction and non-extraction groups, resulting in four groups of 30 patients. The inclusion criteria involved patients aged 12–15 years of age in the permanent dentition with mandibular incisor irregularity of 5–10 mm. At T_0 , MBT brackets were placed and 0.014" NiTi archwires were ligated with non-stretched grey elastomeric modules using either technique. The patients were reviewed six weeks later (T_1), where elastomeric modules were replaced and 0.016" or 0.018" NiTi archwires were inserted. After an additional six weeks ($T_2 - 12$ weeks) the brackets were removed. Impressions for study models were taken at each appointment and the degree of crowding was assessed by one examiner between $T_0 - T_2$ using Little's Irregularity Index.

Results: All four groups showed an improvement in the degree of crowding, with the greatest improvement occurring within the first six weeks. At T_2 , the greatest reduction in crowding of lower incisors was identified in patients with premolar extractions and the use of the figure-of-eight module method; however, this was not significant. Improvement in alignment of lower incisors in male patients was statistically significant when compared with females; however, clinically this represented only 0.2 mm improved alignment per month, which was not significant.

Bracket failures were identified in 26.5% of the patients, of which 60% occurred between $T_0 - T_1$. The majority (45%) of bracket failures happened on the lower incisors, with bracket failure rates of 0.5% per group except for patients with extractions, and the figure-of-eight method had a bracket failure rate of 0.17%. When comparing bracket failure rates between conventional and figure-of-eight module techniques, the failure rates were 4.08% and 3.21%, respectively. Fewer bracket failures were associated with increased age of the patient, but this was not clinically significant.

Conclusion: The findings of this study suggested that using the figure-of-eight module technique to align crowded lower incisors is comparable to using the conventional module method and that there is no significant reduction in bracket failures when using this technique.

Haylea Blundell

Effectiveness of nickel-titanium springs vs elastomeric chains in orthodontic space closure: A systematic review and meta-analysis

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Orthod Craniofac Res 2018; 21: 12-9

Aim: The aim of this study was to evaluate the efficiency of orthodontic space closure using two common methods available to the orthodontist-nickel titanium closing springs (NiTi-CS) and elastomeric power chains (EPC). An assessment was also made of any adverse periodontal effects, cost efficiency and patient-centred outcomes associated with both methods.

Method: The eligibility criteria of the included studies for this systematic review were identified using the PICO method.

- **Population:** Orthodontic patients of any age treated with conventional ligation fixed appliances and requiring space closure secondary to premolar extraction.
- **Intervention:** Orthodontic space closure with NiTi-CS.
- **Comparison:** Orthodontic space closure with EPC.
- **Outcomes:** The primary aim of this systematic review was to compare the clinical performance of NiTi-CS and EPC regarding the rate of space closure. Secondary outcomes were anchorage loss, adverse periodontal effects, cost-effectiveness and patient-centred outcomes. Only human randomised clinical trials (RCTs) were included.

The Cochrane's collaboration tool was used to assess the risk of bias in the included RCTs. Each included study was assessed for the risk of bias in a random sequence generation, allocation concealment, blinding of outcome assessors, incomplete outcome data, selective reporting, and other sources of bias.

Clinical heterogeneity of the included studies was determined prior to the comparisons by assessing the study protocol. Statistical heterogeneity was inspected by checking the chi-squared and I-squared (I^2) values. In cases of substantial heterogeneity ($I^2 > 50$), qualitative interpretation of results was undertaken.

Results: A total of 187 studies were initially identified through the electronic, grey literature and hand searches. Finally, four RCTs met the inclusion criteria and were included in this review. There was perfect agreement between the two reviewers with a Cohen Kappa score of 1.

A statistically significant mean difference favouring fast space closure with the NiTi-CS was observed (MD = 0.20 millimeter/month (mm/mo), 95% CI: 0.12 – 0.28). Both subgroups, split-mouth studies (MD = 0.17 mm/mo, 95% CI: 0.07 – 0.28) and parallel-arm studies (MD = 0.25 mm/mo, 95% CI: 0.11 – 0.38) showed a statistically significant effect estimate favouring the NiTi-CS.

One study reported a mean rate of anchorage loss of 1.1 mm for the NiTi-CS group and 0.82 mm for the EPC group, over a period of four months. Another RCT reported 0.46 mm of anchorage loss for the NiTi-CS group and 0.45 mm for the EPC group while utilising a transpalatal arch as a method of anchorage reinforcement, and expressed the rate of anchorage loss per month.

Conclusions: Both NiTi closing springs and elastomeric chains provided efficient force delivery systems in closing extraction space, with space closure being resultant of anterior teeth retraction, anchorage loss or a combination. There was moderate quality evidence suggesting that a NiTi closing spring produces a faster rate of space closure than the elastomeric chain. This review failed to find any difference in terms of anchorage loss between NiTi closing spring and elastomeric chain. Additionally, no trials were identified that investigated the adverse periodontal effects and/or patient-centred outcomes associated with the two methods of space closure.

Appraisal: This study had clearly defined objectives and was a well-executed systematic review. The research questions and inclusion criteria for the review had a clear PICO, and reviewer agreement was high for study inclusion/exclusion.

The Cochrane risk of bias tool was used to assess methodological validity of the included studies, and a GRADE summary of findings was used to report the

main outcome measures. Importantly, 95% confidence intervals were reported for both the split mouth and parallel-group studies in their respective forest plots following meta-analysis.

Two RCTs reported the means of the outcomes without their respective standard deviations or standard errors. Given that these studies accounted for half the number included in the review, the overall findings could be considered questionable. However, the authors carried out additional analyses to exclude these studies, and the

results demonstrated almost similar results to the original synthesis.

The difference between rates of space closure using NiTi-CS and EPC were statistically significant; however, the reported difference of 0.2 mm/month is small and the clinician would need to assess for themselves whether this is clinically significant, bearing other factors in mind such as cost and clinical efficiency.

Chris Costello