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EDITORIAL

Unified Class II Treatment Protocols

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Editor-in-Chief

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Class II treatment has always fluctuated between 'forward' and 'backward': extraoral traction, maxillary first bicuspid extraction or functional therapy?

In conferences of international importance, surgical therapy (mandibular osteodistraction) of Class II malocclusion caused by mandibular retrusion, the most frequent Class II cases, has recently been proposed also in adolescents.

However, orthodontists should still consider some issues:

- *Is it correct to suggest invasive therapeutic procedures also in cases which may be solved using more conservative therapeutic alternatives?*
- *How much importance should be given to the literature in our clinical practice?*
- *What should the clinician do in case of discordant literature? Which criteria can help him identify the most reliable literature? Does all the literature present the same scientific value?*
- *Wouldn't it be better to follow directions indicated by non 'guru-style' authors that are not linked to a particular school of thought and/or commercial interests?*
- *Isn't the most correct treatment choice the one that provides the best value for the patient in terms of biological cost/aesthetic-functional benefits?*
- *Is it ethically correct that a part of the literature is completely ignored in authoritative international journals and at renowned scientific conferences because it is not considered in vogue?*

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WHO'S WHO

In this section we introduce an influential orthodontist who has given a significant contribution to the specialty. An article by the author featuring his landmarks follows.

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Bonapace C. Sophie Elizabeth Menzel.
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Sophie Elizabeth Menzel

Growing up in a medical family with dinner talk of diagnosis, anamnesis and aetiology, her approach to orthodontics has always been coloured by an interest in health and general medicine. Furthermore, she had the privilege of receiving excellent training at Stellenbosch University, South Africa, where dental and medical students attended the same lectures together for the first three years of their training. In subsequent years of study, the emphasis was always on the interdisciplinary approach and differential diagnosis, working hand in hand with the departments of radiology, oral biology and pathology, maxillo-facial surgery, periodontology, prosthodontics, paedodontics and, of course, orthodontics. She was taught by Professor Emile Rossouw, among others, to consider the overall situation before leaping to superficial conclusions. A patient was never seen as, for example, an orthodontic or periodontic case, but was always evaluated as a whole. Further orthodontic training was influenced by this approach, so that simply creating aligned arches, closed spaces or beautiful smiles never seemed enough, and it became more and more important to also understand the environment we work in. While she was being taught by inspiring postgraduate teachers such as Robert Ricketts, Larry Andrews, Ronald Roth, Charlie Burstone, Hans Pancherz and Douglas Toll, a different approach to orthodontics developed which shaped her future thinking. She joined the University of Kiel in northern Germany for final orthodontic training and met Dr. Axel Bumann, who was a senior resident in the orthodontic department. Several years of studying the management and treatment of complex malocclusions followed. Research on the temporomandibular joint (TMJ) was just starting to evolve as she completed this concentrated and broadly based education. She maintained her interest in the TMJ when she opened her own orthodontic practice and began to treat TMJ disorders. A breakthrough came with the introduction into her practice of the passive self-ligating system developed by Dr. Dwight Damon. With this new and exciting tool she could finally incorporate the concept of gnathology as taught by some of the greatest teachers such as Slavicek, Gutowski and Sato.
Over the last 18 years she has run her own orthodontic practice in Herrsching, southern Germany. She has sought to understand the oral and visceral cranial environment, to simplify the diagnosis of TMJ disorders, to determine their relationship with occlusion and ultimately to treat them orthodontically, keeping financial and treatment efficiency in mind.
When she is not engrossed in orthodontics, she enjoys the outdoors with her husband and children, skiing, mountaineering, cycling, taking photographs and discovering different parts of the world and its cultures.

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Health and Aesthetics in TMJ Orthodontics

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Abstract

With the increased awareness of aesthetics in our society and the respective developments in appliance technology, we need to remember that our profession is still dedicated to contributing to the health of the organism. The main health issue connected with the dentition is craniomandibular disorder. This consists of several different symptoms that all develop from incorrect function and loading of the temporomandibular joint (TMJ). This article concerns itself with a systemic understanding of the interactive coordination of centric relation, the relevance tooth position and arch shape have on centric relation, and how orthodontic treatment can comprehensively contribute to maximal health in TMJ function. The emphasis is on the correct diagnosis of the TMJ disorder, understanding the importance of three-dimensional symmetry, as well as achieving a congruence in both arches and knowing how to obtain this orthodontically. These treatments are all conducted using a centric relation orthotic splint. This article will try to demonstrate how centric relation mandibular positioning is translated into the occlusion by describing a patient case. Furthermore, it will incidentally show how aesthetics is achieved by performing healthy orthodontics.

Keywords
TMJ disorders, centric relation, arch symmetry, mandibular positioning, functional facial asymmetry

“Finally orthodontics may develop into a seriously minded medical profession ther into a primarily aesthetics driven field.”

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INTRODUCTION

I would like to consider the primary functions of the visceral cranium and oral environment in relation to orthodontics. The first function is respiration followed by swallowing and then mastication, which involves the dentition. Respiration and swallowing are essential to life. Consequently, the oral environment must always support breathing and swallowing. The tongue is essential for swallowing, but can be difficult to treat for the maintenance of long term stability. Interestingly, the tongue also has a major impact on the health and longevity of the temporo-mandibular joint (TMJ).

The three roles of the TMJ are: swallowing, mastication and stress management (bruxing and clenching[1]). Mastication is a conscious activity, while swallowing and bruxing/clenching may be performed during sleep and are driven by the subconscious. A further function is speech. Swallowing and grinding are involuntary actions but should not cause collateral pathology. This is ensured by an extremely fine-tuned neurological feedback system in the bilaminary zone of the TMJ. As swallowing does not cause harm to the TMJ or surrounding structures, its effect may be negligible and therefore is not considered here in detail: the importance of swallowing lies in its ability to prevent rather than cause pathology. However, grinding and clenching as involuntary actions have great potential for destructive pathology and in fact are the only cause of TMJ pathology which is not, as often hypothesised, caused by faulty occlusion. However, a malocclusion where the TMJ is not in centric relation will aggravate the pathology caused by bruxism. So, as Rudolf Slavicek maintains, it is our responsibility to facilitate the dentition to grind without causing pathology in the joint and surrounding structures. However, this is not always possible as some patients with perfect occlusion in centric relation do present with TMJ pathology. Nevertheless this is extremely rare and the TMJ responds very well to treatment. To determine its ideal position, the centric relation must be determined.

Centric Relation and Influencing Factors

The TMJ consists of bony components responsible for structural stability, cartilaginous structures that protect and facilitate movement, the joint capsule together with the ligaments, which determine the amount and direction of movement, the muscles controlling movement, and finally the protective feedback tissue in the posterior capsule known as the bilaminary zone[2].

I will discuss the capsular ligament, the disc, the muscles and the bilaminary zone with regard to centric relation. The interaction of these tissues demonstrates how extremely fine tuned the system can be. The musculature never seeks maximal intercuspation but rather guides the mandible into this occlusion with an accuracy of 5 µm, the accompanying structures having been adjusted accordingly.

In centric relation, the condyle and disc are positioned so that the thickest part of the disc, the pars posterior, lies on the most cranial part of the condyle. This is physiologically relevant, as the resilient and pressure-resistant pars posterior can buffer the loading forces caused by bruxism without causing a loss of vertical height in the joint spaces. The vertical height is likewise determined by the mobility of the capsular ligament, which in turn depends on the pars posterior of the disc to maintain this height. In centric relation, all masticatory muscle forces are in equilibrium, thereby ensuring as little active pressure as possible is exerted on the joint structures, to further ensure maintenance of the vertical height[3]. The entire complex is governed by the constant neurological input from the bilaminary zone, reacting to any postural changes with an equilibrated repositioning to ensure mandibular position. This position is not necessarily found in occlusion.

Centric relation is the position maintained by the joint complex at rest. In a fully physiologically functioning system, the tongue is positioned against the palate[4], pushing the mandible forward and downward, thereby exerting a distractive movement and maintaining vertical height in the TMJ joint space during every swallowing motion *(Fig. 1)*. When the tongue is in this mandibular position, the posterior airspace fully opens up, thereby allowing unhindered breathing. We can observe centric relation during speech[5], as the teeth do not determine mandibular position in speech, since no occlusion is adopted. To sum up, centric relation is the joint complex position in which all functions in and around the oral cavity are maximally ensured with little or no pathological effect.

The Dento-Alveolar Effect on the Mandibular Position

Unless there is severe pathology, centric relation at rest is a fixed position in individuals who never clench or grind their teeth. However, as many do grind or clench at some time, the integrity of centric relation may be compromised. During tooth contact, the mandible is

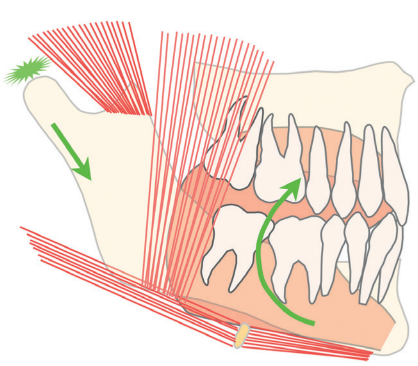

Figure 1: The mobilizing distractive force of the tongue on the temporo-mandibular joint during swallowing.

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not guided by the same mechanisms as in centric relation but is determined by maximal intercuspation rather than the condyle–disc complex. This is physiologically relevant, as the more teeth that are in functional contact with each other, the more efficient is mastication. To facilitate chewing, the healthy centric relation is over-ridden and an alternative, dentally functional mandibular position is adopted. As this position is primarily guided by upper canine to lower canine occlusion, asymmetry in canine position can cause a different lateral positioning of the mandible[6]. This is true for both the upper and lower arches. The difference in the osseous structure of the mandible compared with the maxilla, means that deviations in tooth eruption are much more likely in the maxilla than in the mandible. Very narrowly positioned upper canines, blocked out upper canines (where there is no upper-to-lower canine contact) and a narrow upper premolar arch may force the mandible backwards into a retrusive position, more commonly known as an Angle Class II malocclusion. This may result in a shift in the condyle and disc relation, forcing the condyle backwards and slipping the disc anteriorly, causing what is known as anterior disc displacement. Most disc displacements are likely a combination of retro-positioning of the condyle and an anterior disc shift.

Over 19 years of diagnosing and treating TMJ malocclusions in my practice, I have devised a system of general classification consistent with Angle classification. This classification consists of three groups, with the first group having the least and the last group the largest surface area of pathological impact. These groups are briefly mentioned below with reference to their malocclusions, with examples shown in *Figures 2–4*.

During mastication, occlusion-based mandibular positioning is of little or no consequence since we only chew for an average of 6–10 min daily. However, it is of pathological significance when accompanied by involuntary bruxism and clenching, which exerts a muscular force 10–15 times higher than that of mastication and causes significantly more damage[7]. However, if the individual can maintain an Angle Class I mandibular position at rest and only deviates into Class II for masticatory occlusion, resetting the dentition into a arch shape that allows an Angle Class I maximal occlusion during effective mastication, may significantly reduce the chances of pathology.

A large-scale study to determine how many malocclusions are driven by maxillary versus mandibular misalignments would be statistically interesting. Only 2–3% of my patients present with mandibular asymmetry, thereby suggesting that most asymmetries are located in the maxilla *(Fig. 5)*. In my practice I have developed a system to analyze maxillary asymmetries according to the following criteria as defined in *Figure 5:*

1. central suture-related arch symmetry[8];
2. canine symmetry;
3. molar symmetry.

Vertical Cranial Force
with Loss of Support in the Molar Region

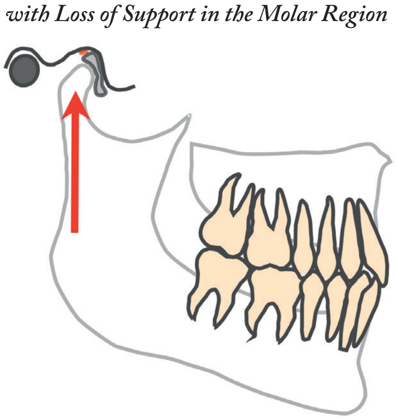

Figure 2: Angle Class I deep bite (caused by iatrogenic factors, such as dental restoration, extractions, bruxism and clenching).

Dorso-cranial Force
with Compromised Posterior Vertical Height

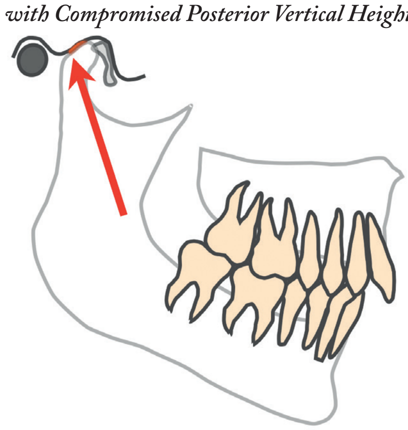

Figure 3: Angle Class II divisions 1 and 2 malocclusion (caused by extractions or Angle Class III forced into Class I).

Dorsal Cranial Force
with Dropping of Occlusal Plane

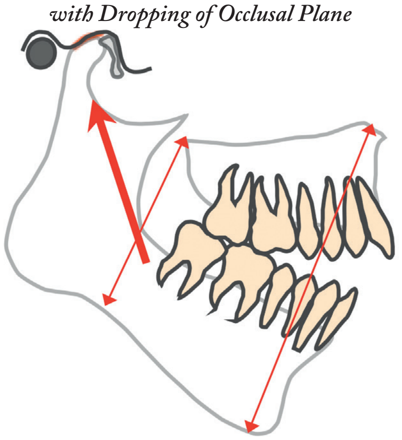

Figure 4: High angle dolichofacial Class II malocclusion (caused by anterior open bite with tongue thrust, extractions, high angle cases, and overextrusion of the molars).

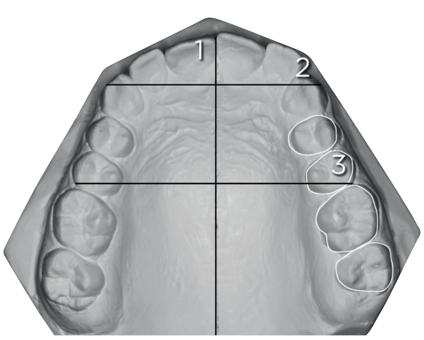

Figure 5: Maxillary cast with superimposed and mirrored right-hand side on the left arch, demonstrating asymmetrical alignment leading to bite asymmetries. 1. central suture-related arch symmetry; 2. canine symmetry; 3. molar symmetry.

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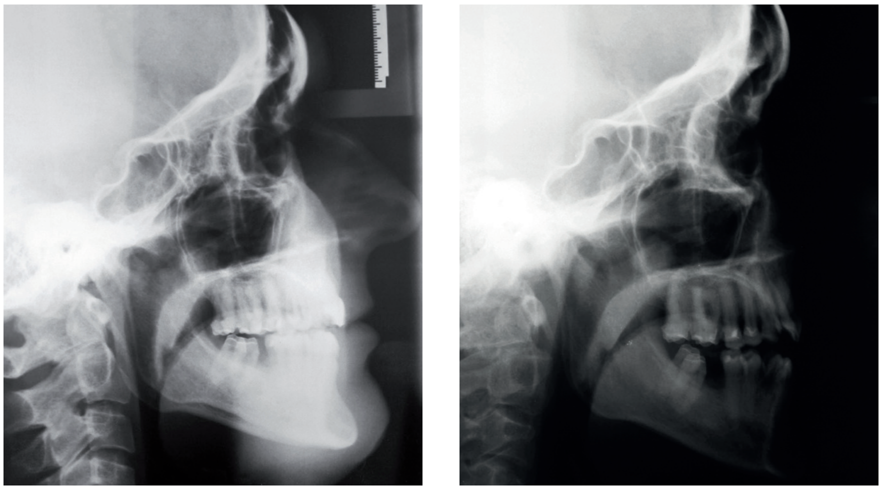

Figure 6: Cephalometric x-ray of 57-year-old patient before (left) and during splint treatment (right), demonstrating the significant increase in posterior airspace.

Figure 7: A change in upper arch shape in a severe Class II malocclusion can facilitate mandibular forward posturing.

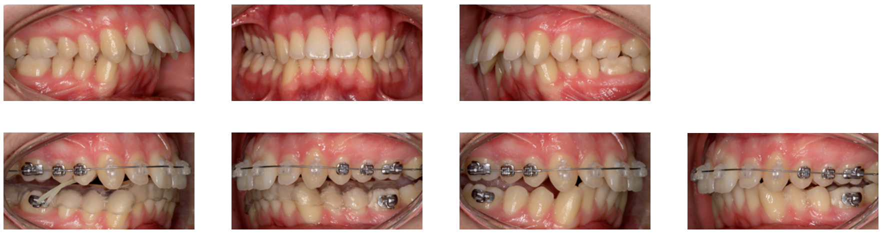

Figure 8: Phase one Class II correction splint and early elastics results after only 6 months.

Figure 9: Treatment result at debonding (top) and stability check 26 months after treatment (bottom). Note the post-treatment correction of the second molars into a fully occluding Angle Class I relationship.

To summarize, the mandible is the determining factor for TMJ-oriented orthodontic treatment: the mandible in centric relation must always determine how the alignment of the maxilla should be performed. Ultimately, the repositioned mandible should be stabilized in a symmetrical Angle Class I occlusion[9].

Disarticulation and Orthodontic Correction

Repositioning of the mandible is achieved in my practice with the use of a splint in centric relation, which the patient wears full time for a minimum of 3 months before orthodontic treatment. These splints are placed in the lower arch for a number of reasons:

1. aesthetic considerations and compliance
2. functional comfort especially during speech
3. maintenance of the mandibular position during the first phase of corrective orthodontic treatment in the maxilla.

During the first phase of orthodontic treatment, my aim is to develop an ideal maxillary constellation which can support the mandible in its corrected centric relation. Letting the patient wear the splint continually during this part of treatment, allows for constant re-evaluation of the progress of the changes in the upper arch with respect to the mandibular position. Furthermore, it helps to reorient surrounding structures, such as the fibrous structures of the TMJ capsule and ligaments, as well as the muscular force vectors. Insufficient posterior airspace in some patients is also enhanced by the splint as the tongue space is increased vertically and sometimes sagittally *(Fig. 6)*.

Lower arch treatment is only begun when the most significant intermaxillary corrections stemming from the maxilla have been made. Therefore, all maxillary asymmetries, be they transverse, sagittal or vertical, as well as that part of Angle Class II correction that is related to the maxilla, must be corrected before full bond-up of the lower arch is started *(Fig. 7)*. The reason for this is that the splint in combination with early elastics, serves as an anchorage system and facilitates dento-alveolar correction of the asymmetry/Class II without having a negative effect on the lower incisors as is often observed in full bond-ups *(Fig. 8)*. Interestingly, I have noted a significant change in the occlusal plane enhancing Class II corrections. Oral hygiene is also improved as cleaning only one bonded jaw is always easier than cleaning two. Dento-alveolar correction of the lower arch is usually much simpler than that of the upper and therefore does not need the same amount of time.

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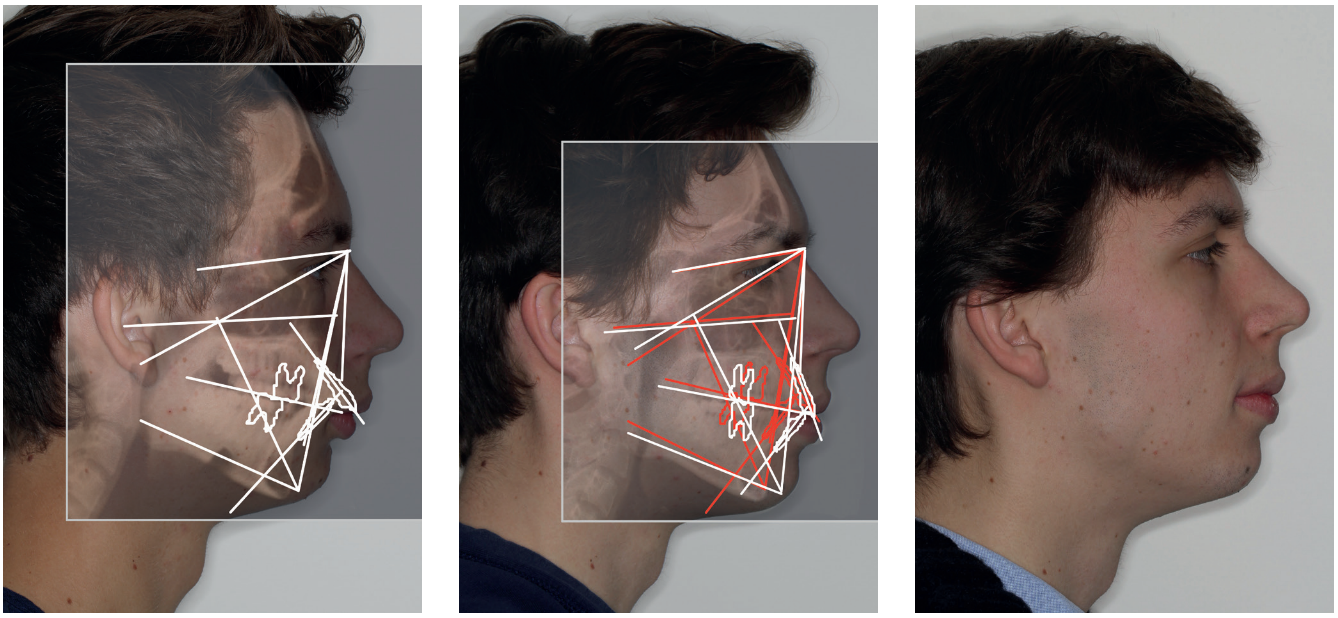

Figure 10: Cephalometric analysis demonstrating full Class II correction (centre). Note the unchanged facial surface of the upper incisor, and significant changes in mandibular posture and occlusal plane. Compare the apparently stable 26-month post-treatment profile result (far right).

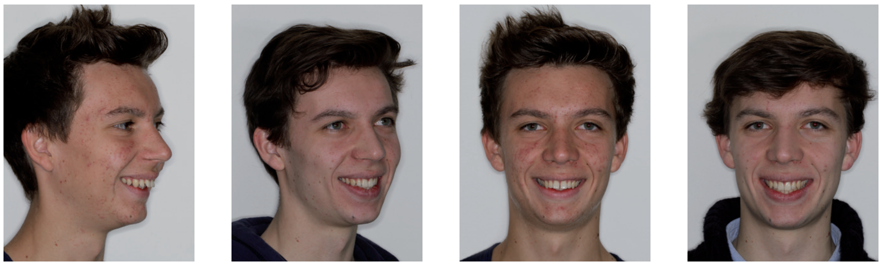

Figure 11: Optimized facial harmony as viewed from 45° (left and mid-left) and the front (mid-right and right) following 22 months of orthodontic treatment in an non-growing individual. Note incisal show and pleasing lip support.

Once maxillary correction is completed and the mandibular posture has been stabilized[10], the lower bond-up is done to settle and finalise occlusion of the upper to the lower arch, and usually consists mainly of uprighting lateral segments, alignment of crowded anterior teeth, and the correction of deep or open bites *(Fig. 9)*. This second phase of orthodontic treatment is often accompanied by anterior bite disarticulation to facilitate the above-mentioned treatment course.

Post-treatment stabilisation in Class II malocclusions is usually performed 1 year after treatment with a positioner appliance such as a Damon splint. The change in mandibular position and its long term stability is significant as shown in *Figure 10*. The facial harmony achieved utilizing this treatment is demonstrated in *Figure 11*. However, where vertical corrections are performed for deep or open bites, these forms of retainers are not required. As most TMJ patients are either grinders or clenchers, some form of grinding splint should be worn at night to protect the dental structures and support the TMJ tissues until the habit reduces in intensity.

CASE REPORT OF SEVERE TEMPORO-MANDIBULAR DISORDER

This case was sent to my office by an orthodontic colleague who realised that the instability of the patient's orthodontic correction might be due to an underlying TMJ pathology.

The patient presented with the following TMJ-related symptoms:

1. severe debilitating migraine-like headaches on a daily basis
2. nausea
3. dizziness
4. severe neck tension resulting in the headaches.

The patient was aged 16 and had been hospitalised due to these symptoms and had missed significant time at school. Her initial orthodontic complaint was, that after 4.5 years of a fixed appliance, her teeth were rapidly shifting into disalignment again. As in many of our patients, she was unaware that her symptoms were related to her dental situation.

Treatment began with splint therapy that greatly relieved her cranio-mandibular pain. After 3 months she decided to undergo renewed orthodontic treatment. Her headaches, nausea and dizzy spells, as well as severe neck tension, were eliminated. However, all symptoms recurred as soon as she left the splint out for more than 3 h.

Figure 12: Maximal occlusion (top) and inserted splint (bottom) eliminating pathological symptoms and revealing the severity of maxillary cant.

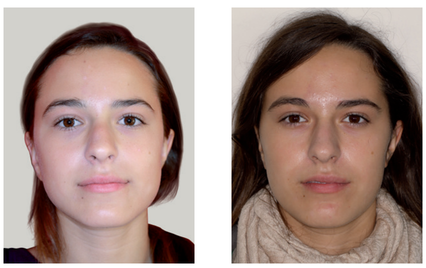

Figure 13: The patient in frontal view in occlusion (left) and on splint (right). Note the asymmetrical alignment of the lip contour in comparison to the bipupillary line as well as the orientation of the chin and mandibular ramus angles.

Figure 14 Bonded upper teeth with a lower splint and extrusion mechanics on the left side (top) until the molars/premolars are level to the right (bottom series) with the splint as worn (bottom right) by the patient.

Figure 15: Fully bonded second phase of treatment, still using a partial splint for patient comfort. Compliance dependent use of elastic bands was employed to angle canines parallel and symmetrically to allow for equal laterotrusion left and right. Note changed incisor and canine cant in the middle series. Debonding took place after 23 months (lower series).

Panoramic and cephalometric x-rays showed distinct compression of the left TMJ. A vertical discrepancy between left and right was also seen, with the right-hand side showing significantly more dento-alveolar development than the left side and a much steeper inclination of the right upper canine compared to the relatively flared left canine *(Fig. 12)*[11]. This was aggravating the vertical asymmetry, causing further impaction and intrusion on the left-hand side, causing noticeable facial asymmetries as shown in *Figure 13*, as mastication was not possible on the steeply inclined canine side (the patient's right-hand side). A flared left upper canine allows for much easier laterotrusive shifting during mastication. The patient's chewing patterns supported the clinical observation as she was only chewing on the left-hand side and was unable to perform a right laterotrusive movement. Intra-oral photographs and articulated model analysis confirmed the clinical and radiological diagnosis. When the patient received a centric relation splint, masticatory function was improved and both sides showed equal functional shifts during chewing (shown by observing the shift patterns when the patient was chewing gum).

During phase one of the orthodontic treatment *(Fig. 14)*, the focus was on canine alignment and maxillary symmetry and an extrusion was performed on the left-hand upper arch to correct the maxillary cant. The splint was worn continuously during this phase and reduced occlusally on the left to allow for the maxillary extrusion *(Fig. 16)*. Once upper arch symmetry had been achieved and the vertical height was levelled out from right to left in the molar–premolar segments, a molar supported occlusion was introduced to maintain the stability created with the splint and the splint was then removed. Normally, when a splint is removed, an anterior bite turbo is placed to provide maximum occlusal stability. However, our patient had a slight tendency to an open bite, so anterior bite turbos were not necessary.

In the second phase of treatment, full bond-up of the lower arch was performed, the splint was removed, and the bite settled with an extensive elastic protocol. During this final part of the treatment, the emphasis lay on correction of the incisal cant to align the patient's smile arc with an equal amount of dental show from left to right *(Fig. 15)*. The occlusion was stabilised into a bilateral Angle Class I relation before the appliance was removed. Treatment time was 23 months.

Post-treatment stabilization was performed with a Damon splint positioner. The patient wore it regularly at night for 1.5 years and still uses it occasionally at night especially during phases of stress.

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Figure 16: Change in maxillary symmetry during the first and second phases of treatment. Note how the central suture straightens out.

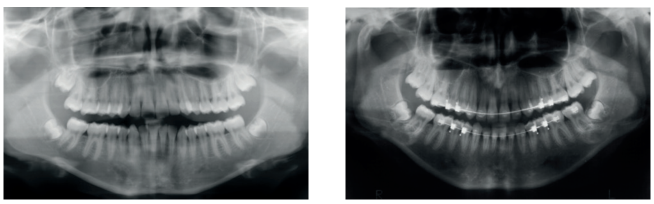

Figure 17: Panoramic radiograph before treatment (left) and before debonding (right). Note canine angulation and incisal cant change.

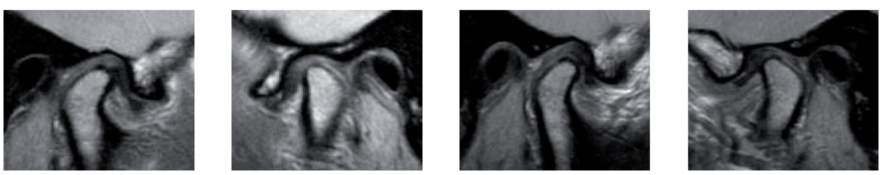

Figure 18: MRI scans of the temporo-mandibular joint showing the shifted condylar position with resultant partial disc displacement in the right joint and full disc displacement in left joint (left series). Treatment resulted in full repositioning of the right disc and partial repositioning and good structural adaptation of the left disc (right series).

Figure 19: Changed facial symmetry and correction of cant with equal dental show on left and right sides after treatment.

CONCLUSION

The initial intra-oral photographs of this patient do not suggest such a severe malocclusion. Consideration of her facial asymmetry-related temporo-mandibular disorder and determination of her actual mandibular position in centric relation[12], allowed an aesthetically pleasing, pathology-free occlusion to be achieved *(Figs. 17 and 18)*.

I have often noticed in treatment where the emphasis is on a functionally healthy outcome, that the aesthetics are always ultimately pleasing *(Fig. 19)*[13]. This may be because patients in pain and with pathology may not feel beautiful. However, a healthy system will be much more likely to be aesthetically pleasing. Either way, the orthodontics performed in these cases are by far the most rewarding experience I come across in my daily work!

REFERENCE LIST

1. Slavicek R, Sato S. Bruxism–a function of the masticatory organ to cope with stress. *Wien Med Wochenschr* 2004;**154**:584–589.
2. Bumann A, Lotzmann U, Mah J. *TMJ Disorders and Orofacial Pain. Color Atlas of Dental Medicine, Vol. 12*. 1st edn. Stuttgart: Thieme, 2002, pp. 16–44.
3. Parker WS. Centric relation and centric occlusion–an orthodontic responsibility. *Am J Or-thod* 1978;**74**:481.
4. Takahashi S, Kuribayashi G, Ono T. Modulation of masticatory muscle activity by tongue position. *Angle Orthod* 2005;**75**:35–39.
5. Pound, Earl. *The Vertical Dimension of Speech: The Pilot of Occlusion*. www.glidewelldental.com/downloads/dentist/education/articles/ivm14_vertical_dimension.pdf (accessed 20 April 2015).
6. Yamada K, Hanada K, Sultana MH. The relationship between frontal facial morphology and oc-clusal force in orthodontic patients with temporomandibular disorder. *J Oral Rehabil* 2000;**27**:413–421.
7. Lantada A, Bris C, Morgado P. Novel system for bite-force sensing and monitoring based on magnetic near field communication. *Sensors* 2012;**12**:11544–11558.
8. Hayashi K, Muguruma T, Hamaya M. Morphologic characteristics of the dentition and palate in cases of skeletal asymmetry. *Angle Orthod* 2004;**74**:26–30.
9. Lundh H, Westesson PL, Erikson L. Disk-repositioning onlays in treatment of TMJ disk dis-placement: comparison with flat occlusal splint and with no treatment. *Oral Surg Oral Med Oral Path* 1988;**66**:155–162.
10. Fidler B, Artun J, Joondeph D. Long-term stability of Angle class II, division 1 malocclusions with successful occlusal results at end of active treatment. *Am J Orthod Dentofacial Orthop* 1995;**107**:276–285.
11. Padwa B, Kaiser M, Kaban L. Occlusal cant in the frontal plane as a reflection of facial symmetry. *J Oral Maxillofac Surg* 1997;**55**:811–816.
12. Inui M, Fushima K, Sato S. Facial asymmetry in temporomandibular joint disorders. *J Oral Rehabil* 1999;**26**:402–406.
13. Jefferson Y. Facial beauty-establishing a universal standard. *Int J Orthod* 2004;**15**:9–22.

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CLINICAL ARTICLE

MAPA: a New High-precision 3D Method of Palatal Miniscrew Placement

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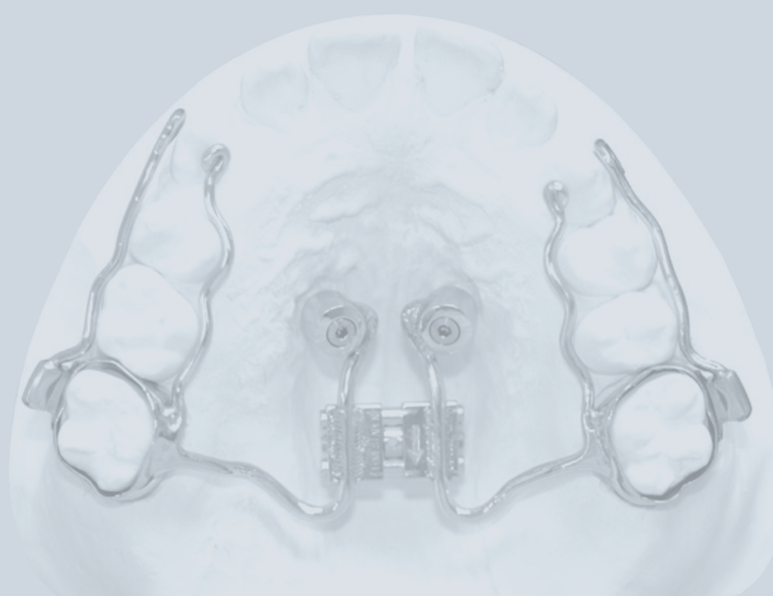
Abstract

This article describes a new insertion guide system that facilitates the precise directional positioning of miniscrews on the palate. The MAPA (MAino-PAoletto) guide is made with the aid of cone-beam computed tomography (CBCT) images and digital casts. The development of purpose-designed software has enabled the design and construction of insertion guides that allow good exploitation of available bone, making miniscrews placement safer and more precise.
The application of this method to a clinical case is discussed, as well as the indications, efficacy and possible complications of the device.



Keywords
Digital printing, miniscrew, mini-implant, stent, template, insertion guide, stereolithographic guide, palatal miniscrew insertion guide, Class III

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INTRODUCTION

Insertion of miniscrews for orthodontic anchorage into the palatal vault is finding ever more applications in the field of dentistry[1–5]. This anchorage site is useful for both biomechanical and, especially, anatomical reasons, as there are no roots that could interfere with miniscrew insertion[6–8]. Nevertheless, the palate does not present a uniform thickness, varying from individual to individual[9,10], and great care therefore needs to be taken to analyze the availability of bone to guarantee good primary stability and reliable anchorage[11,12].

In recent years, volumetric tomography and purpose-designed software have enabled the design and construction of templates that allow good exploitation of the available bone, making miniscrew placement safer and more precise[13]. These 3D guides are generally constructed for miniscrew placement in the inter-radicular spaces, specifically to prevent any damage to tooth roots[14–16]. However, we present here a miniscrew insertion guide designed specifically for palatal application. This template is able to ensure not only miniscrews are placed at the correct depth in the maxillary bone, but also that multiple implants are parallel. It is therefore suitable for miniscrews destined for the anchorage of removable devices, as well as pre-formed and tailored appliances used in fixed orthodontics.

MATERIALS AND METHODS

Identification of miniscrew insertion sites

In order to correctly position miniscrews in the palate and guarantee that they are parallel, it is essential to perform a thorough evaluation of the maxillary bone structure. The most precise imaging technique in this regard is cone-beam computed tomography (CBCT), which should be performed with the mouth lightly open. In order to ensure that the occlusal surfaces do not overlap, and that the patient can maintain the correct position during the scan, a roll of cotton wool should be placed between the patient's teeth *(Fig. 1)* (KaVo 3D eXam). A DICOM file of the image is generated that should enable identification of the anatomical structures in the roof of the palate, and thereby the most suitable sites for miniscrew insertion.

Should the use of CBCT merely for miniscrew placement be considered too risky for the patients, exposing them to a relatively large amount of radiation[17], it is possible to use teleradiography instead. Indeed, according to Kim et al., palatal thicknesses measured via laterolateral teleradiography are comparable to those measured on CBCT scans taken roughly 5 mm from the midsagittal plane[18]. Nevertheless, teleradiography must not be performed without intraoral positioning of a thermoplastic PET-G bite, cast on the patient's plaster model, featuring a series of radio-opaque markers along the medial palatine raphe *(Fig. 2)*. This will enable precise reconstruction of the profile of the palatal mucosa on the scanned image (after factoring in the magnification of the scanning device itself).

Contemporaneously, on an STL file obtained by scanning the stone model (3shape D800 scanner) or the impression of the patient's upper arch, two ideal miniscrews insertion points (IIPs) are identified in the anterior portion of the palate, preferably in an area between the distal surfaces of the canines and the mesial surfaces of the second premolars *(Fig. 3)*, bearing in mind that the ideal distance between the two is, in most cases, 10 mm.

Next, the digital model of the upper arch is superimposed onto the DICOM file *(Fig. 4)* or the lateral x-ray *(Fig. 5)*, enabling identification of the most suitable anteroposterior placement, based on the width and thickness of the palatal vault. This operation is performed using a proprietary software method (eXam Vision software integrated with Rhinoceros software).

Next, by means of STL files, miniscrews are virtually 'inserted' *(Fig. 6)* into the palate. By varying the position of the virtual implant, the miniscrew of greatest length compatible with the patient's anatomy can be selected on

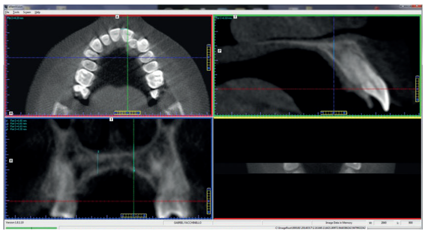

Figure 1: DICOM file of the cone-beam computed tomography (CBCT) scan.

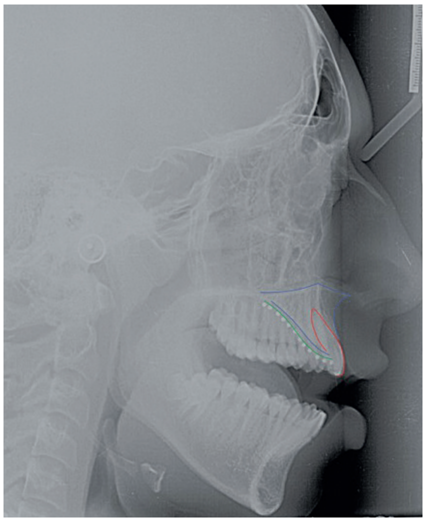

Figure 2: X-ray and lateral cephalogram showing radio-opaque markers along the medial palatine raphe.

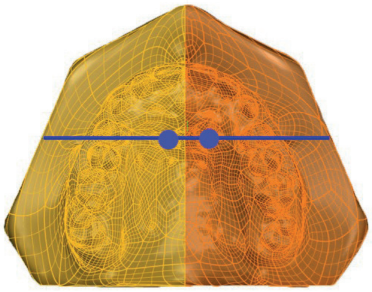

Figure 3: STL model and ideal miniscrew insertion point (IIPS).

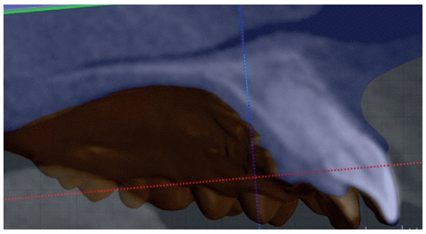

Figure 4: Superimposition of the digital model on CBCT.

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the basis of the availability of bone. Modification of the virtual miniscrew angle and insertion points should enable the identification of sites with sufficient bone to allow application of miniscrews of at least 9 mm in length. In order to better exploit the available bone, miniscrews (Spider Screw Regular Plus) should be inserted with an anterior inclination *(Fig. 6)*[19], at an angle compatible with the bands that will be welded to the device[20]. At this point, it would be opportune to check the overall plan in 3D to ensure that the miniscrew length is suitable and that the programmed placement is parallel *(Fig. 7)*.

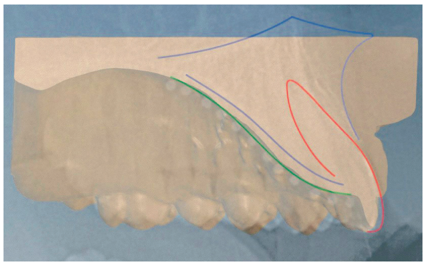

Figure 5: Superimposition of the digital model on the lateral cephalogram.

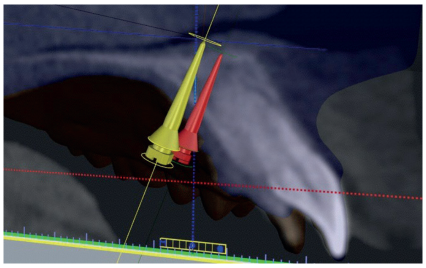

Figure 6: STL files showing an inserted miniscrew on the sagittal plane of the cone-beam computed tomography (CBCT) scan passing through the ideal insertion point.

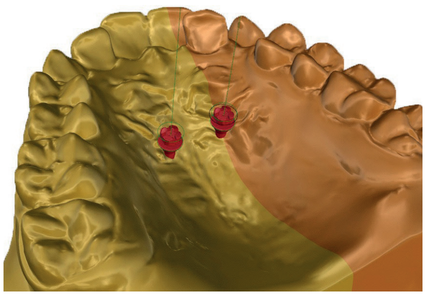

Figure 7: Checking the inclination between the axis of the miniscrew and the axis of the molars.

Template design

The insertion guide is designed to rest upon the occlusal surfaces of the posterior teeth *(Fig. 8)* and act as a precise guide to the insertion site, specifically its location, depth and the direction of miniscrew application. It must be stable, and permit good visibility and easy removal once the miniscrews are in place. The use of STL images of the miniscrews and pick-up driver during the design phase enables the faithful reproduction of their measurements, in particular the transmucosal portion of the miniscrews and the insertion device *(Fig. 9)*. These measurements will be transferred to the internal part of the two cylindrical guides designed to replicate the angle of insertion and prevent the screws from penetrating beyond the required depth. The cylindrical guides are virtually joined to the template by means of resin bridges *(Fig. 10)*. The guide is then 3D-printed in a transparent material (DWS 3D printer Digital Wax 020), to ensure maximum visibility during the insertion procedure, and that the resin bridges can be easily detached from the body of the guide and subsequently removed *(Fig. 11)*. Insertion will be facilitated by a 'window' in each cylinder, purpose-designed to enable the orthodontist to check the progress of the operation and ensure that the miniscrew has reached the programmed depth.

Miniscrew application

After local anaesthesia to the palatal site (2% lidocaine), the surgical guide is fitted, making sure that it rests on the occlusal surfaces of the posterior teeth. If required, a small amount of light-cure resin (Triad; Dentsply, York, Pennsylvania, USA) can be used to bond the template to the occlusal surfaces of the first premolars.

Two self-tapping, self-drilling miniscrews (Spider Screw Regular Plus) capable of accepting an abutment fixed with a microscrew *(Fig. 12)* are selected, picked up with the specific driver – mounted on a low-speed contra-angle handpiece

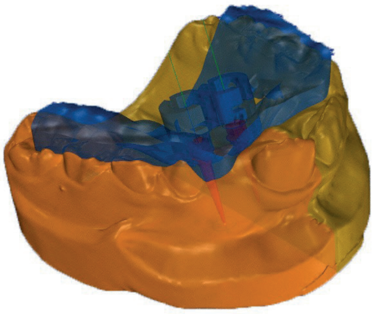

Figure 8: The template resting on the occlusal surface of the posterior teeth.

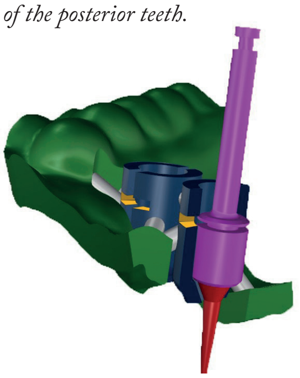

Figure 9: Section of the insertion guide showing the STL files of the miniscrew and pick-up driver.

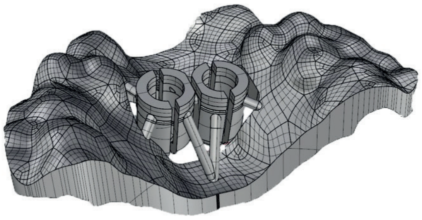

Figure 10: Connection bridges between the cylindrical guide and the template body.

(50 rpm) – and by these means inserted into the apposite guide cylinder of the template. The design of the clear cylinder will ensure that the screw is inserted at the right angle and to the required depth. Indeed, the guide is able to replicate with extreme precision the transmucosal portion of the miniscrew and driver, and can prevent the screw exceeding the pre-programmed depth. The horizontal viewing window in each cylinder is positioned at exactly the height of the pick-up driver head, providing the operator with a direct view of the insertion progress, and blocking the driving action when the upper margin of the pick-up driver reaches the

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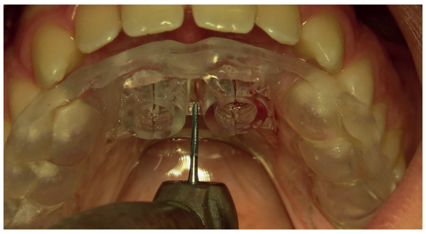

Figure 11: Cylindrical guide removal after miniscrew insertion.

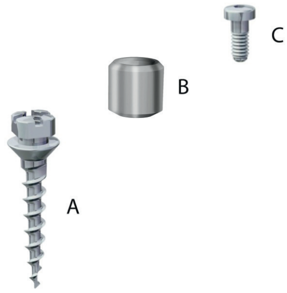

Figure 12: Hybrid rapid palatal expander (RPE) components: (A) Spider Screw Regular Plus, (B) abutment, (C) fixation screw.

Figure 13: Bands on first molars and pick-up coping in place for the polyvinyl siloxane (PVS) impression.

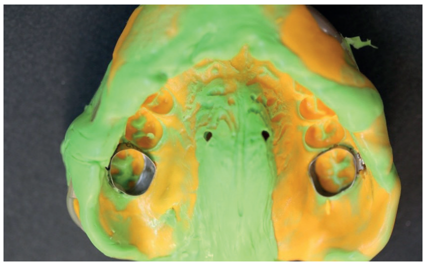

Figure 14: Polyvinyl siloxane (PVS) impression.

Figure 15: Stone model.

lower margin of the viewing window. Once the miniscrews are in place, the resin bridges connecting the cylinders from the body of the guide can be cut *(Fig. 11)*, and the resulting sections of the template can easily be removed.

Construction of the orthodontic device

At this point, the anchorage bands can be fitted onto the first molars. Two plastic transfer copings *(Fig. 13)* are then simply clicked onto the heads of the miniscrews, and a plastic tray is used to take a silicon or vinyl polysiloxane precision impression *(Fig. 14)* so that the position of the miniscrews can be replicated on the plaster models *(Fig. 15)*. The orthodontic device SKAR III (Skeletal Alt-RAMEC for Class III) applied in this case is a rapid palatal expander (RPE), with mixed dental/skeletal anchorage, featuring welded vestibular arms to hold a face-mask *(Fig. 16)*. Two metal abutments designed to fit over the heads of the miniscrews (Spider Screw Regular Plus) are welded on the anterior metal arms of the RPE, and each is fixed in place by means of a microscrew fitted with an appropriate driver.

CASE REPORT

Diagnosis

An 8-year-old male patient attended a consultation, seeking treatment for anterior crossbite. Facial analysis revealed labial incompetence, slight mandibular protrusion, and maxillary retrusion, which was particularly evident when the patient smiled *(Figs. 17 and 18)*. Intraoral examination revealed healthy periodontal tissues, upper jaw constriction, and anterior and posterior crossbite *(Figs. 19–24)*.

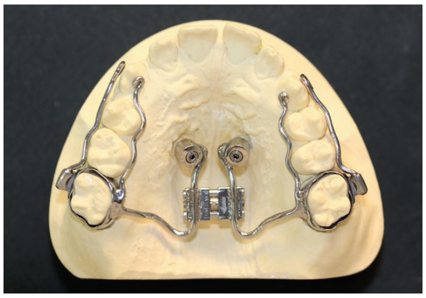

Figure 16: SKAR III (Skeletal Alt-RAMEC for Class III malocclusion).

Occlusion was severe dental Class III on both sides *(Figs. 20 and 21)*. A panoramic radiograph *(Fig. 25)* showed the patient to be in mixed dentition. A cranial laterolateral teleradiograph *(Fig. 26)* and associated cephalometric tracing *(Fig. 27)* confirmed severe skeletal Class III, lower incisor lingual inclination and hypodivergence *(Table 1)*.

Figures 17 and 18: Pre-treatment extraoral photos of the 8-year-old patient with skeletal Class III malocclusion.

Treatment objectives and treatment planning

The main objective of treatment was to expand and advance the upper jaw, minimizing the dental effects so as to obviate the need for subsequent compensatory measures. Hence we elected to use an RPE with mixed dental/skeletal anchorage, followed by a facial mask.

Treatment progress

Bands were positioned on the upper second deciduous molars and two 9 mm Spider Screw Regular Plus miniscrews inserted into the palate at the level of the first deciduous molars *(Fig. 28)*. The transfer copings were inserted by pressing on the miniscrews, and polyvinyl siloxane (PVS) precision impressions were taken. At this point a SKAR III appliance was constructed and anchored to the molar bands. Two vestibular arms were soldered onto the buccal side of the bands to be used for maxillary elastics, and two lingual arms were soldered onto the lingual aspect to distribute the force to the canine and first deciduous molars *(Fig. 29)*. Skeletal anchorage was provided by screwing metal abutments to the miniscrews fixed in the palate.

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Figures 19–24: Pre-treatment intraoral photos of the 8-year-old patient with skeletal Class III malocclusion.

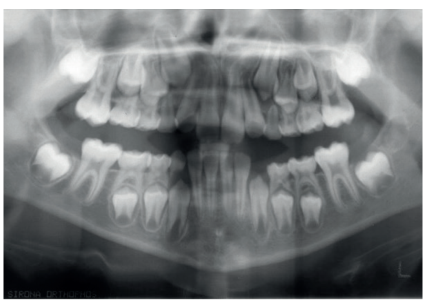


Figure 25: Panoramic radiograph.

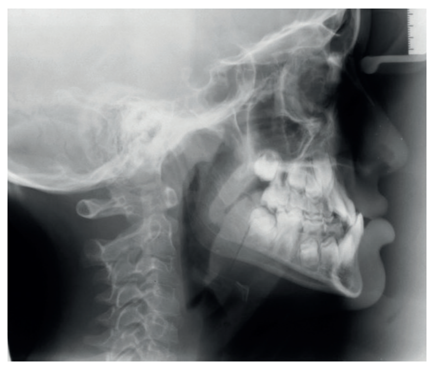


Figure 26: Lateral cephalogram.

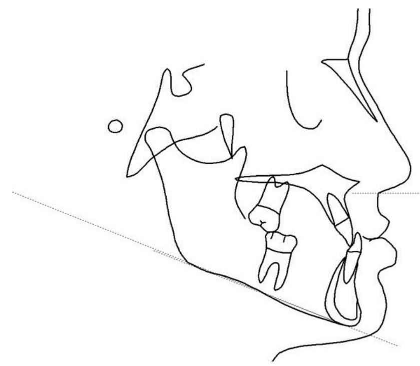


Figure 27: Pre-treatment tracing.

Figure 28: Two Spider Screw Regular Plus miniscrews inserted into the palate.

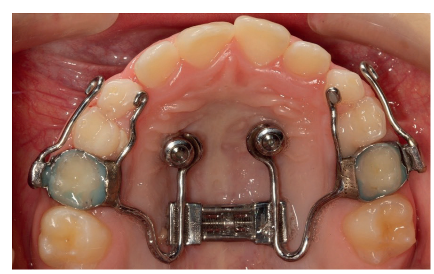
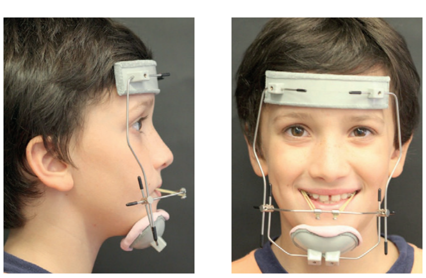


Figure 29: SKAR III appliance.

Figures 30–32: Intraoral photos after Liou's Alt-RAMEC protocol.



Figures 33 and 34: Starting the face mask.

Figures 35 and 36: Extraoral photos after 6 months of face-mask treatment .

Liou's protocol[21,22] was followed to bring about the maxillary expansion and mobilization, with the aim of achieving the required amount of occlusal overcorrection *(Figs. 30–32)*. The expansion phase was followed by the use of the face-mask: 4 months worn 14 h per day *(Figs. 33 and 34)* and 7 months worn only during the night, which brought

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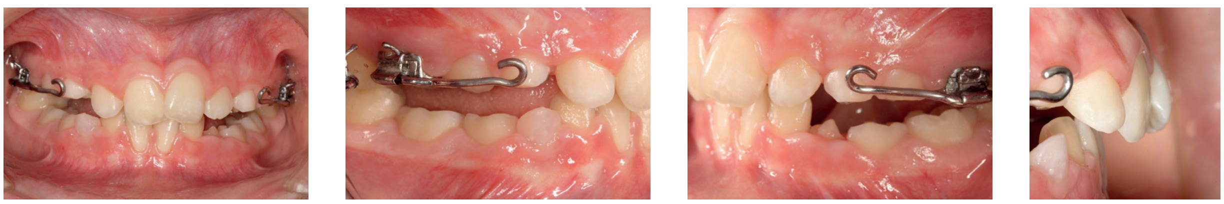
Measurements	Pre-treatment	Post-treatment
SNA	81	85
SNB	80.5	81
ANB	-0.5	4
WITS	-5	0
IMPA	79	77
SN-GoGn	37	37

Table 1: Cephalometric values (degrees).



Figures 37–40: Intraoral photos after 6 months of face-mask treatment.

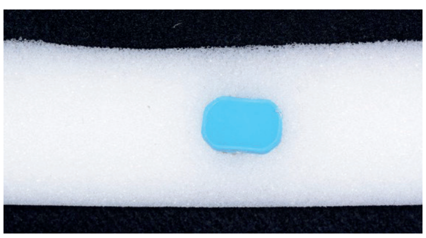


Figure 41: Microsensor embedded into the sponge of the support front.

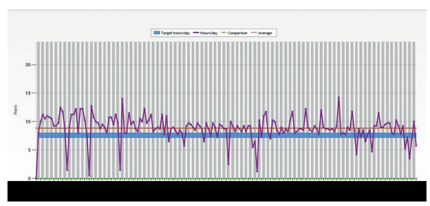


Figure 42: Graphic with wearing information for the face mask during the last 5 months of treatment.

about a considerable improvement in the sagittal relationship *(Figs. 35–40)*. Compliance was verified by a removable orthodontic appliance called TheraMon. The TheraMon chip offers more advantages xas a result of its smaller size (9x13 mm) and its increased accuracy and reliability[23-26]. A microsensor was embedded into the sponge of the support front *(Fig. 41)* and identified temperature changes, which are then transformed to wear time information *(Fig. 42)*. Indeed, radiography *(Fig. 43)* and cephalometric tracing *(Fig. 44)* show a large increase in upper jaw prominence, i.e. a 3.6° increase in the SNA angle, an increase of 7.5° in the ANB angle, a Wits index reduced to zero, slight lingual inclination of the lower incisors, and an increase in the divergency *(Table 1)*. Complete superimposition on the cranial base shows the forward and downward growth of the maxilla associated with the greater prominence of the upper jaw, while changes in the lower jaw appear to be negligible *(Fig. 45)*.

TREATMENT RESULT

After 12 months of treatment, the extraoral photos show the improved lip profile and the greater prominence of the upper jaw at the middle third of the face *(Fig. 36)*. The occlusal view *(Figs. 37–40)* shows how expansion has changed the shape of the arch, increasing the space available for the right upper canine.

DISCUSSION AND CONCLUSIONS

Skeletal anchorage has opened new frontiers in orthodontic treatment, and enabled the development of new techniques that provide good quality, predictable results[1-5]. The success of miniscrew techniques, such as that used here, depends upon the availability of supporting bone, and the use of miniscrews whose length and diameter allow the best use to be made of this support for anchorage.
Cutting-edge imaging techniques such as CBCT and digital laser

Figure 43: Post-treatment lateral cephalometry .

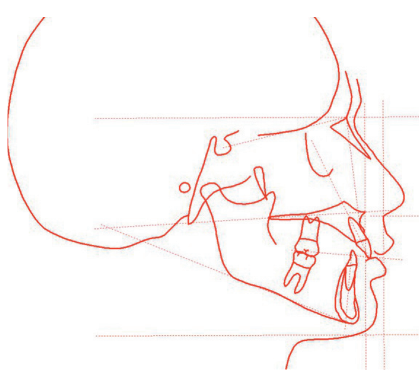


Figure 44: Post-treatment tracing.

Figure 45: Complete superimposition.

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scanning have also fuelled great leaps forward, and combining these with 3D printing has enabled the construction of tailored surgical guides that facilitate the precise directional positioning of miniscrews. This approach optimizes and improves the safety of miniscrew placement, which can be inserted at the correct angle to the correct depth even by relatively inexperienced dental surgeons[13–15]. Indeed, surgical guides like the one presented here make miniscrew insertion a simple, reproducible and reliable procedure, and the construction of such orthodontic aids is likely to become even more precise and less complicated as the technology advances. This will undoubtedly enable the orthodontist to achieve more predictable results within a reasonable, and perhaps even reduced, time-frame.

REFERENCE LIST

1. Lee J, Miyazawa K, Tabuchi M, Kawaguchi M, Shibata M, Goto S. Midpalatal miniscrews and high-pull headgear for anteroposterior and vertical anchorage control: cephalometric comparisons of treatment changes. *Am J Orthod Dentofacial Orthop* 2013;**144**:238–250.
2. Suzuki EY, Suzuki B. Maxillary molar distalization with the indirect Palatal miniscrew for Anchorage and Distalization Appliance (iPANDA). *Orthodontics (Chic.)* 2013;**14**:e228–241.
3. Kim KB, Helmkamp ME. Miniscrew implant-supported rapid maxillary expansion. *J Clin Orthod* 2012;**46**:608–612.
4. Razavi MR. Molar intrusion using miniscrew palatal anchorage. *J Clin Orthod* 2012;**46**:493–498.
5. Kang YG, Kim JY, Nam JH. Control of maxillary dentition with 2 midpalatal orthodontic miniscrews. *Am J Orthod Dentofacial Orthop* 2011;**140**:879–885.
6. Deguchi T, Nasu M, Murakami K, Yabuuchi T, Kamioka H, Takano-Yamamoto T. Quantitative evaluation of cortical bone thickness with computed tomographic scanning for orthodontic implants. *Am J Orthod Dentofacial Orthop* 2006;**129**:721.e7–12.
7. Poggio PM, Incorvati C, Velo S, Carano A. “Safe zones”: a guide for miniscrew positioning in the maxillary and mandibular arch. *Angle Orthod* 2006;**76**:191–197.
8. Choi JH, Yu HS, Lee KJ, Park YC. Three-dimensional evaluation of maxillary anterior alveolar bone for optimal placement of miniscrew implants. *Korean J Orthod* 2014;**44**:54–61.
9. Gracco A, Lombardo L, Cozzani M, Siciliani G. Quantitative cone-beam computed tomography evaluation of palatal bone thickness for orthodontic miniscrew placement. *Am J Orthod Dentofacial Orthop* 2008;**134**:361–369.
10. Winsauer H, Vlachojannis C, Bumann A, Vlachojannis J, Chrubasik S. Paramedian vertical palatal bone height for mini-implant insertion: a systematic review. *Eur J Orthod* 2014;**36**:541–549.
11. Ludwig B, Glasl B, Bowman SJ, Wilmes B, Kinzinger GS, Lisson JA. Anatomical guidelines for miniscrew insertion: palatal sites. *J Clin Orthod* 2011;**45**:433–441.
12. Maequezan M, Nojima LI, Ayres de Freitas AO, Baratieri C, Junior MA, Nojima M, et al. Tomographic mapping of the hard palate and overlying mucosa. *Braz Oral Res* 2012;**26**:36–42.
13. Kitai N, Yasuda Y, Takada K. A stent fabricated on a selectively colored stereo lithographic model for placement of orthodontic mini-implants. *Int J Adult Orthodon Orthognath Surg* 2002;**17**:264–266.
14. Miyazawa K, Kawaguchi M, Tabuchi M, Goto S. Accurate presurgical determination for self-drilling miniscrew implant placement using surgical guides and cone-beam computed tomography. *Eur J Orthod* 2010;**32**:735–740.
15. Kim SH, Choi YS, Hwang EH, Chung KR, Kook YA, Nelson G. Surgical positioning of orthodontic mini-implants with guides fabricated on models replicated with cone-beam computed tomography. *Am J Orthodon Dentofacial Orthop* 2007;**131**:S82–S89.
16. Liu H, Liu DX, Wang G, Wang CL, Zhao Z. Accuracy of surgical positioning of orthodontic miniscrews with a computer-aided design and manufacturing template. *Am J Orthod Dentofacial Orthop* 2010;**137**:728.e1–728.e10.
17. *Cone Beam CT for Dental and Maxillofacial Radiology. Evidence-Based Guidelines*. A report prepared by the SEDENTEXCT project. Available from http://www.sedentexct.eu/files/radiation_protection_172.pdf
18. Kim YJ, Lim SH, Gang SN. Comparison of cephalometric measurements and cone-beam computed tomography-based measurements of palatal bone thickness. *Am J Orthod Dentofacial Orthop* 2014;**145**:165–172.
19. Maino BG, Bednar J, Pagin P, Mura P. The spider screw for skeletal anchorage. *J Clin Orthod* 2003;**37**:90–97.
20. Maino BG, Mura P, Maino G, Paoletto E. Impianti palatini a scopo di ancoraggio ortodontico: metodica di precisione “MAPA” per la programmazione del sito implantare. *Mondo Ortodontico* 2004;**Feb**:97–106.
21. Liou EJ. Effective maxillary orthopedic protraction for growing Class III patients: a clinical application simulates distraction osteogenesis. *Prog Orthod* 2005;**6**:154–171.
22. Allegrini S, Paoletto E. Espansione e protrazione del mascellare in dentatura mista e permanente con tecnica di Liou modificata. 22. *Ortodonzia tecnica* 2009;**3**:7–13.
23. Schott TC, Ludwig B, Glasl BA, Lisson JA. A microsensor for monitoring removable-appliance wear. *J Clin Orthod* 2011;**45**:5181; Or
24. Schott TC, Goz G. Applicative characteristics of new microelectronic sensors Smart Retainer(R) and TheraMon(R) for measuring wear time. *J Orofac Orthop* 2010;**71**:339–347.
25. Ackerman MB, Thornton B. Posttreatment compliance with removable maxillary retention in a teenage population: a short-term randomized clinical trial. *Orthodontics (Chic.)* 2011;**12**:22–27.
26. Tsomos G, Ludwig B, Grossen J, Pazera P, Gkantidis N. Objective as-sessment of patient compliance with removable orthodontic appliances: a cross-sectional cohort study. *Angle Orthod* 2014;**84**:56–61.

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The Invisible Canine Exposure Plate

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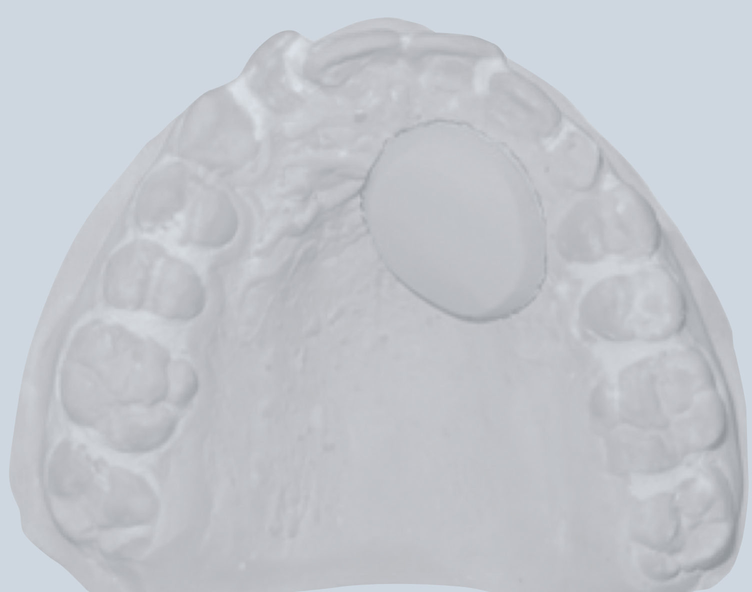
“A thermoformed appliance incorporating a reservoir for periodontal dressing material following canine exposure”

Abstract

Impacted teeth can cause resorption of adjacent tooth roots, cysts and their position can preclude orthodontic tooth movement. Open exposures for palatally impacted canines usually require the use of a cover plate, which have traditionally been constructed as a modified wire/acrylic removable orthodontic appliance. Thermoformed polyurethane orthodontic retainer material can also be used to produce a vacuum-formed cover plate containing a reservoir for the periodontal dressing material. This has a number of advantages over traditional wire/acrylic cover plates including manufacturing simplicity, no requirement for adjustment of clasps during surgery, significantly reduced cost and improved patient comfort.
This article illustrates the laboratory and clinical steps involved in the manufacture of vacuum-formed cover plates for early healing following exposure of palatally impacted maxillary canines.



Keywords
Exposure, healing, cover plate

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INTRODUCTION

Impacted maxillary canines occur in 1-3% of the population[1] and are the second most commonly impacted teeth after the third molars[2]. Around 90% of impacted maxillary canines are palatal, whilst the remaining 10% are buccal[3].

Impacted maxillary canine teeth can cause resorption of adjacent tooth roots[3] or cysts and their position can preclude other orthodontic tooth movement. The management of impacted teeth usually involves surgical exposure, surgical removal or long-term radiographic monitoring[4]. Surgical exposure and orthodontic traction is regarded as the optimum method of managing palatally impacted maxillary canines. The surgery involves either a closed eruption or an open eruption technique as follows[5]:

Closed-eruption technique

Following removal of any bone and follicular tissue overlying the crown, a bracket and chain are bonded and the flap is re-sutured. Subsequently, fixed appliance orthodontic treatment is used to mechanically erupt the canine through the mucosa prior to alignment[4].

Open-eruption technique

The open-eruption technique relies on a degree of spontaneous eruption of the impacted canine after a mucosal window has been made at the time of surgery. However, this requires the mucosa to heal around the exposed crown and fixed orthodontic appliances must be used to prevent re-growth of the mucosa over the exposed canine prior to alignment[4]. Two methods are used for this. Traditionally, a periodontal bandage containing 80% zinc oxide paste and 9% magnesium was placed over the operative area and sutured to the mucosa. The contemporary method involves the use of a cover plate, which has a number of functions, including the application of a periodontal dressing material to retard mucosal healing, the prevention of wound trauma and allowing limited oral hygiene measures to be used.

Cover plates have traditionally been constructed using wire clasps, an acrylic base-plate with full palatal coverage and a reservoir made over and around the exposed canine to accommodate the periodontal pack that is applied directly after the exposure[6]. These are usually made by a dental technician with specific skills in making orthodontic appliances, although the clasps frequently require adjustment in the operating theatre to ensure adequate retention of the appliance.

In 1971, Robert Ponitz, from Michigan, was the first to introduce thermoplastic materials to orthodontics, and since then, they have been used for temporomandibular joint splints, night and sports guards, bleaching trays and for orthodontic retainers. Invisible thermoforming materials are of particular benefit to patients with particular professional and social needs[7-8]. Currently, the predominant thermoforming materials that are used in clear orthodontic appliances are polypropylene, polyurethane and polyester. We present a new and straightforward method of constructing a canine exposure cover plate using vacuum-formed materials by providing a reservoir to accommodate the periodontal pack after a canine exposure.

METHOD OF CONSTRUCTION

Like most appliances, this appliance is produced on a plaster model that is normally cast from an alginate impression of the patient's maxillary arch. Minimal model preparation is required, although the location of the reservoir should be marked in pencil *(Fig. 1)* and large undercuts should be filled with a plaster 'wash' *(Fig. 2)*.

In order to create a reservoir for the periodontal pack over the planned exposed canine area, 1-2mm height of lab putty or plaster is placed in a circular shape over the planned exposure area *(Fig. 2)*. The thermoforming sheet is then heated using infrared radiation in a thermoforming machine (Biostar/Ministar, Great Lakes Orthodontics,

Figure 1: Model with anticipated location of canine (marked in pencil line).

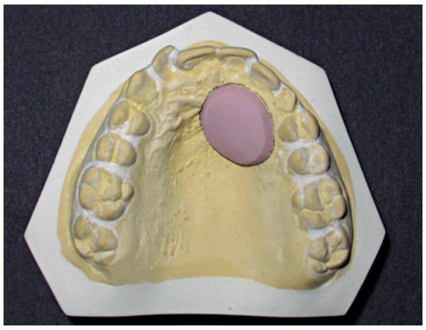

Figure 2: Model with Lab Putty reservoir and plaster wash.

Figure 3: Completed appliance.

Figure 4: Appliance fitted prior to surgery.

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	Acrylic	Thermoformed
Manufacture	Inexpensive materials, relatively time consuming and complex construction.	Inexpensive materials, relatively quick and simple construction.
Surgical	Usually require adjustment of clasps at operation. Food debris can collect under fitting surface.	No adjustment required. Close fit ensures good mechanical protection for surgical site.
Orthodontic	Other removable appliance components can be included (springs/bite planes). Trim to allow canine to erupt.	No scope for other tooth movements. Limited scope for adjustment as canine erupts.

Table 1: Comparison of acrylic and thermoformed cover plates.

New York) and applied to the cast before the vacuum pressure is applied. Once cooled, the appliance is trimmed and decontaminated *(Fig. 3)*.
The appliance is then ready to be fitted prior to surgical procedure *(Fig. 4)*.
At the end of the surgical procedure, periodontal dressing material is placed in the reservoir. As with an acrylic cover plate, the thermoformed cover plate is worn full-time for one week before being removed at a review appointment. After that, the orthodontic mechanics to erupt the exposed canine is planned in more detail once the cover plate has been removed.

DISCUSSION

The advantages and disadvantages of acrylic and thermoformed cover plates are detailed in *Table 1*. In particular, the close fit of the thermoformed canine exposure plate with the mucosa ensures mechanical protection for the surgical wound, minimises post-operative haemorrhage by maintenance of the blood clot, and supports any mobile teeth. The appliance also facilitates rapid healing by preventing food and other debris from entering the surgical site, while the design of the reservoir can help with moulding the periodontal tissue in the surgical site. Furthermore, the close fit of the appliance to the teeth and palatal mucosa provides improved patient comfort when compared to traditional acrylic appliances[6]. Finally, the rapid fabrication of thermoformed appliances means that laboratory costs are significantly reduced and no specific orthodontic technical skills are required. Although less clinical time is required because clasps or acrylic do not require adjustment/trimming, the location of the reservoir needs to be carefully planned in advance.

CONCLUSION

The invisible canine exposure plate has a number of advantages over traditional wire/acrylic cover plates, including manufacturing simplicity, no requirement for adjustment of clasps during surgery, significantly reduced cost and improved patient comfort.

REFERENCE LIST

1. Lai CS, Bornstein MM, Mock L, Heuberger BM, Dietrich T, Katsaros C. Impacted maxillary canines and root resorptions of neighbouring teeth: a radiographic analysis using cone-beam computed tomography. *Eur J Orthod* 2013;**35**:529-538.
2. Walker L, Enciso R, Mah J. Three-dimensional localization of maxillary canines with cone-beam computed tomography. *Am J Orthod Dentofac Orthop* 2005;**128**:418-423.
3. Ericson S, Kurol J. Incisor resorptions due to ectopic maxillary canines imaged by computerized tomography: a comparative study in extracted teeth. *Angle Orthod* 2000;**70**:276-283.
4. Fleming PS, Sharma PK, DiBiase AT. How to...mechanically erupt a palatal canine. *J. Orthod* 2010;**37**:262-271.
5. Pearson MH, Robinson SN, Reed R, Birnie DJ, Zaki GA. Management of palatally impacted canines: the findings of a collaborative study. *Eur J Orthod* 1997;**19**:511-515.
6. Milton TM, Murray PG, Irvine GH. Use of a removable healing plate in establishing successful exposure. *Br J Oral Maxillofac Surg* 2003;**41**:264-265.
7. Gardner GD, Dunn WJ, Taloumis L. Wear comparison of thermoplastic materials used for orthodontic retainers. *Am J Orthod Dentofac Orthop* 2003;**124**:294-297.
8. Zhang N, Bai Y, Ding X, Zhang Y. Preparation and characterization of thermoplastic materials for invisible orthodontics. *Dent Mater J* 2011;**30**:954-959.

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Dental Plaque Assessment When a Fixed Appliance Is Used

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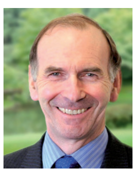

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Abstract

Introduction
During orthodontic treatment, because of the presence of brackets, plaque progressively accumulates in a different distribution on the tooth surface, and any method of assessment should consider this difference. The clinical records of a patient are used to assess the advocated methods.

Methods
Twenty-four subjects, with a mean age of 12.6 years, took part in a cross-sectional clinical trial. Photographs were taken of a tooth and four methods to score plaque, namely (1) area measurement, (2) the original, (3) the modified Silness–Löe plaque index and finally (4) the bonded bracket plaque index (BBPI), were assessed.

Results
Intraclass correlation coefficients and weighted kappa were used for analysis. The area measurement and Silness–Löe index showed a substantial level of agreement. For the modified Silness–Löe index, the agreement was moderate (0.54). The agreement for the BBPI was rated as only fair (0.38).

Conclusions
This clinical trial assessed and compared several methods of scoring plaque. The reproducibility and validity vary amongst the methods. The modified Silness–Löe index is the most appropriate index for use in practice. The area measurement method was the most reproducible, but takes longer and is suited to research.

“*The Modified Silness–Löe index is suited for Clinical Practice*”

Keywords
Dental plaque, orthodontic appliances, index, reproducibility, practicability

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INTRODUCTION

Dental plaque is considered the main aetiological factor in dental caries and periodontal disease, and orthodontic treatment with fixed appliances is a risk factor for plaque accumulation[1]. This increases the risk of enamel decalcification and gingivitis or possibly more serious periodontal disease. Assessment of dental plaque is therefore essential in the evaluation of the oral hygiene of individual patients undergoing fixed appliance treatment and for clinical studies measuring plaque in such patients.

During orthodontic treatment, because of the presence of brackets and archwires, plaque progressively accumulates in a different distribution on the tooth surface and any method of assessment should take account of this difference. A recent review found that only a small minority of studies of such patients had used a method which took into account this altered plaque distribution[2]. That review concluded that three measures were potentially the most appropriate to quantify the extent of plaque in patients wearing fixed orthodontic appliances. The most common basis for plaque scoring has been the use of a numerical scale i.e. an index, most commonly the original index of Silness and Löe[3]. This index is a subjective evaluation, based on the plaque thickness near the gingival margin and the coronal extension of plaque covering the tooth surface, but it has been adapted for the different pattern of plaque accumulation in orthodontic patients and used in several studies of orthodontic patients[4–7]. In order to address the effect of orthodontic brackets on plaque distribution, this modified Silness and Löe index[4] divides the buccal surface of the tooth into medial, distal, gingival and incisal regions in relation to the bracket *(Fig. 1)*.

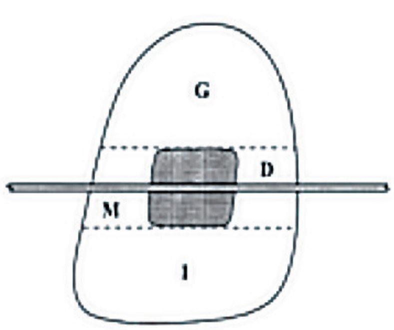

Figure 1: The modified Silness–Löe index[4].

Plaque is then scored in each area according to the codes used in the original Silness–Löe index and summed to give a total score. This index acknowledges the different pattern of plaque accumulation with orthodontic appliances, but is correspondingly more complex than the original Silness–Löe index. The bonded bracket plaque index (BBPI) assumes a progressive outward spread of plaque from the orthodontic bracket. It has been used in three studies[8–10]. *Table 1* shows how plaque is scored.

A further method expresses the plaque area not as a categorical index, but as a percentage of the labial tooth surface covered with plaque. It has been used in two studies of orthodontic patients[4,11,12]. The area covered by plaque is calculated on clinical photographs and expressed as a percentage of the total labial tooth surface area. The advantages of a photograph for any measure of plaque distribution are that it can be assessed at leisure, is a permanent record and can be viewed on multiple occasions. One investigation compared this percentage plaque area method with the modified Silness–Löe index to assess plaque in patients wearing fixed appliances[4]. They used standardized photographic views of disclosed teeth and reported in an abstract only that either method could be of value in studies of the oral hygiene involving fixed appliances. They recommended that the choice should depend on factors of convenience and cost. Two more recent studies used a rigorously standardized photographic technique and employed a more sophisticated method to identify disclosed plaque and calculate its surface area by means of software identification of pixels of a chosen colour range[11,12]. This method is a development of that previously proposed and assessed in non-orthodontic patients[13,14].

Relatively few studies of patients wearing fixed orthodontic appliances have used indices specifically designed to score plaque in such patients and only two papers have reported on the reproducibility of methods of quantifying plaque in such patients[4,11]. The aim of this study is to assess the best method to score plaque during orthodontic treatment and a clinical case of one patient involved will be demonstrated.

MATERIALS AND METHODS

This cross-sectional clinical trial was conducted in the University of Bristol Dental Hospital Orthodontic Department. Ethical committee approval was granted by the North Somerset and South Bristol Research Ethics Committee. Informed consent was obtained from all the participants at the start of treatment.

The participants were 24 consecutively started patients aged 11–14 years (12 males and 12 females, mean age 12.6 years, SD 1.01) undergoing upper and lower fixed appliances using Damon 2 self-ligating brackets (Ormco, Orange, CA, USA). The exclusion criteria were:

1. Patients requiring arch expansion, or distalization of molars, with auxiliary appliances since these additional appliances may interfere with oral hygiene practices.
2. The presence of systemic disease.
3. A history of systemic antibiotic treatment in the last three months.

Clinical photographs of the upper left lateral incisor were taken and evaluated because it has been shown that the upper lateral incisors are prone to decalcification[15]. The teeth were disclosed with Butler Red-Cote® dental disclosing agent

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(Gum Butler, Chicago, USA) and then photographed by one operator using a Canon EOS 350 digital camera (Canon Inc., Tokyo, Japan) with standardized exposure settings, *e.g.* the depth of field (f)=23. All four methods were investigated on the photographs. Replicate measurements were taken in the same order at 1-week intervals. All measurements were made by one investigator (SAA). Orthognathic Planning and Analysis (OPAL™, available through the British Orthodontic Society, London, UK) software was used to measure the areas of plaque from the digital images. This patient is used to illustrate the method *(Fig. 2)*. The digital photographs of the teeth were digitized on-screen, and the area of plaque was measured and divided by the whole crown measurement to give the percentage of the labial crown surface covered by plaque *(Fig. 3)*.

Timing of the methods used

All four methods were timed using a stopwatch in a standardized manner (n=10). The timing started when the clinical photographs were displayed on the screen and stopped when the final value was written on paper.

Statistical analysis

Intraclass correlation coefficients were calculated to examine the random error for continuous measures. A weighted kappa statistic was used to examine the agreement of replicate categorical data.

RESULTS

Systematic errors

The mean differences were small *(Table 2)* and indeed statistical analysis was not to investigate the systematic error between the replicate series of measurements of any of the methods. For the area measurement and the Silness–Löe plaque index, *Table 3* shows that there is a substantial level of agreement for the photographs. For the modified Silness–Löe plaque index,

Figures 2a: A girl involved in the trial. Pre-treatment photographs showing a Class III malocclusion with an impacted maxillary right canine, a crossbite and a centreline discrepancy. Clinical photographs demonstrating the teeth which have been disclosed at the start and three months into treatment.

Figure 2b: Mid-treatment photographs illustrating the progress of her treatment.

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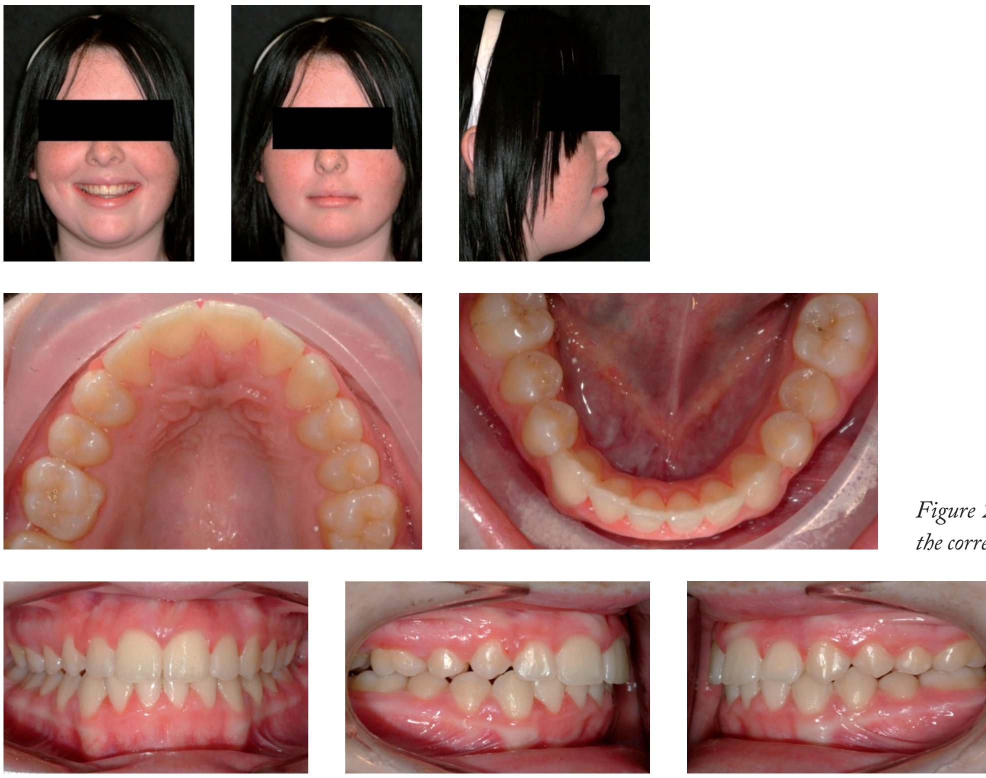

Figure 2c: Post-operative photographs showing the correction of the crossbite and the centreline.

0	No microbial plaque on the bracket or the tooth surface
1	Microbial plaque only on the bracket
2	Microbial plaque on the bracket and tooth surface, but not spreading towards the gingiva
3	Microbial plaque on the bracket and tooth surface, spreading toward the papilla
4	Microbial plaque on the bracket and tooth surface, part of the gingiva is covered with plaque
5	Microbial plaque on the bracket and tooth surface, gingiva is totally covered with plaque

Table 1: The five different categories for scoring plaque in the Bonded Bracket Plaque Index (BBPI) as described by Kilicoglu et al[8].

	T0	T1
Area measurement	50.01	48.89
Original plaque index	3.40	3.18
Modified plaque index	10.3	9.6
BBPI	3.54	3.54

Table 2: The mean values for the four plaque scoring methods on two separate occasions (one week interval) in T1, at the start of treatment and T2, 3 months later.

the agreement for the photographic measurements should be described as moderate (0.54). The agreement for the BBPI is rated as only fair (0.38).

The mean scoring time for each method was examined using the clinical photographs. *Table 4* contains the mean scoring times for each method. It can be seen that the area measurement method takes significantly longer per tooth than the other three methods.

DISCUSSION

Area measurement

In this method, the clinical photographs were used to measure the percentage area covered by plaque. It could be argued that this method is the most objective of the four and will therefore give the most accurate representation of the amount of plaque present. The reproducibility was found to be high (*Table 2*).

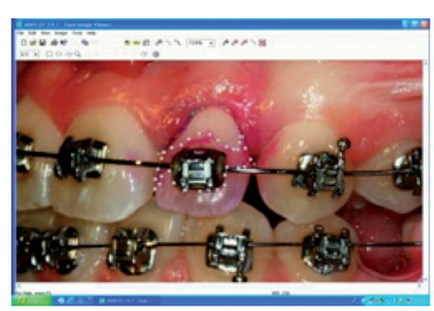

Figure 3: An OPAL screen showing the digitized outline of the plaque on the upper left lateral incisor of another patient involved in the trial.

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Measuring plaque from the photographs is challenging, because the measurer needs to identify the boundary of the plaque lesion. Furthermore, image analysis systems can be used to quantify plaque. In one study, in which the image of the patient's teeth was analyzed using Adobe Photoshop (V5.02, Adobe Systems Ltd, Europe) and Image Pro Plus software (V4.0, Media Cybernetics, USA), it was found that this system provided accurate quantitative measurements of dental plaque and labial tooth surfaces[8].
Williams et al. appear to have used a similar method of measurement and reported that measuring plaque from clinical photographs was sensitive; they recommended this method of scoring plaque[4]. However, there are potential disadvantages and limitations with this method. Firstly, it is more complicated and time consuming. It took significantly longer to score one tooth than the other three methods *(Table 4)*. Secondly, it ignores the question as to which areas of the tooth are most susceptible to plaque accumulation, *i.e.* it gives no indication of which area of the tooth was covered with plaque, and this may be of clinical significance. It may be that this method is more suited to research than to use in clinical practice, where a quicker method is preferable.

The original Silness–Löe plaque index

Most orthodontic studies that have assessed plaque levels associated with fixed appliances have used the original Silness–Löe plaque index; however, the majority have not reported the reproducibility of their method, which is a serious limitation. The original Silness–Löe plaque index is the simplest method and requires the least chairside time. The potential disadvantage with this method is that it ignores the possible effects of the presence of a bracket on the tooth surface, and this has been shown to alter the pattern of plaque accumulation[1]. For example, a small amount of plaque mesial to the bracket scores 2, whereas the same amount of plaque at the gingival margin scores 1. The literature search revealed no previous reports on the reproducibility of this method in orthodontic patients.

Modified Silness–Löe plaque index

Williams et al. found that this index was sensitive in detecting differences in plaque levels in orthodontic patients with fixed appliances[4]. In the current study, it was found that the reproducibility of the modified Silness–Löe index was moderate for the clinical photograph *(Table 3)*. This may be accounted for by the fact that in the photograph, the measurer has to re-identify the area of plaque on the two occasions. The fact that this index reflects and identifies the distribution of plaque around the bracket is an advantage when compared to the original Silness–Löe index, which is based on a different pattern of plaque accumulation. It is not possible to compare statistically the ranking order of plaque coverage in a sample with the two methods, because of the differences in the number and nature of the categories. From a clinician's point of view, the original index was found to very slightly quicker to use *(Table 4)*. However, the modified index has been designed to be sensitive to detect areas of plaque in relation to the bracket and archwire. This in turn may have an influence in directing oral hygiene procedures on these susceptible areas to reduce the risk of developing dental caries and periodontal disease. The large number of studies which have used the original Silness–Löe index probably reflects the slightly greater ease of use of this index and the greater familiarity with this index in the literature.

	ICC	95 % CI		
Area measurement	0.90	0.83-0.98		
Modified Silness and Löe plaque index	0.54	0.25-0.84		
	Kappa	95 % CI	Std. Err	*P*
Silness and Löe plaque index	0.61	0.25- 0.97	0.18	0.002
BBPI	0.38	0.03-0.60	0.13	0.002

Table 3. The random error for the four plaque scoring methods. 95% CI= Confidence interval, ICC= Intraclass correlation, Std. Err. = Standard Error.P = P value.

	Mean (seconds)	Standard Deviation	95%Confidence interval	Range
Area measurement	64.6	7.3	63.2-66	55-76
Original Silness and Löe	3.2	1.8	4.3-2.1	3-5
Modified Silness and Löe	4.5	1.7	7.9-10.5	3-7
BBPI	8.5	0.8	7.4-6.2	6-12

Table 4. Mean scoring time for each plaque scoring method in seconds. This was carried out by one operator.

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The bonded bracket plaque index (BBPI)

This index is largely based on the Silness–Löe index but also takes account of the presence of an orthodontic bracket[8]. There are some codes in this index which are difficult or perhaps illogical to apply. For example, in Code 4, 'microbial plaque on the bracket and tooth surface, where part of the gingiva is covered with plaque'. Does this index intend to score plaque on the soft tissues? Furthermore, there are no previous studies in the literature that have tested the reproducibility of this index. It may be argued that in the presence of simpler and more practical indices to score plaque in orthodontic patients wearing fixed appliances, the BBPI has a limited role.

Clinical implications

As shown in the clinical case *(Fig. 2)*, the use of the original Silness–Löe plaque index is not recommended in orthodontic patients as it ignores the presence of orthodontic brackets. The modified version of the Silness–Löe plaque index takes into account this aspect and might be used for routine clinical practice. The area measurement method takes significantly longer to score plaque, but is numerical and objective and may therefore be better suited for research purposes. The use of clinical photographs to score plaque is recommended in the area measurement method because they are simple and quick to collect, they provide a permanent record, which can be properly masked and scored at leisure, and reproducibility can be assessed.

CONCLUSIONS

- The modified Silness–Löe plaque index is recommended as the most appropriate index for use in orthodontic clinical practice, as demonstrated in the case report in this study.
- The on-screen area measurement method was the most reproducible and objective but takes significantly longer and may be more suited to research investigations.

REFERENCE LIST

1. Zachrisson S, Zachrisson, BU. Gingival condition associated with orthodontic treatment. *Angle Orthod* 1972;**42**:26–34.
2. Al-Anezi SA, Harradine NWT. Quantifying plaque during orthodontic treatment: a systematic review. *Angle Orthod* 2012;**82**:748–753.
3. Silness J, Löe H. Periodontal disease in pregnancy. Correlation between oral hygiene and periodontal condition. *Acta Odont Scand* 1964;**22**:121–135.
4. Williams P, Clerehugh V, Worthington HV, Shaw WC. Comparison of two plaque indices for use in fixed orthodontic appliance patients. *J Dent Res* 1991;**70**:703. Abstract 276.
5. Clerehugh V, Williams P, Shaw WC, Worthington HV, Warren P. A practice-based randomised controlled trial of the efficacy of an electric and a manual toothbrush on gingival health in patients with fixed orthodontic appliances. *J Dent* 1998;**26**:633–639.
6. Thienpont V, Dermaut LR, Van Maele G. Comparative study of 2 electric and 2 manual toothbrushes in patients with fixed orthodontic appliances. *Am J Orthod Dentofacial Orthop* 2001;**120**:353–360.
7. Costa MA, Silva VC, Miqui MN, Sakima T, Spolidorio DMP, Cirelli JA. Efficacy of ultrasonic, electric and manual toothbrushes in patients with fixed orthodontic appliances. *Am J Orthod Dentofacial Orthop* 2007;**77**:361–366.
8. Kilicoglu H, Yildirim M, Polater H. Comparison of the effectiveness of two types of toothbrushes on oral hygiene of patients undergoing orthodontic treatment with fixed appliances. *Am J Orthod Dentofacial Orthop* 1997;**111**:591–594.
9. Turkkahraman, Sayin O, Bozkurt FY, Yetkin Z, Kaya S, Onal S. Archwire ligation techniques, microbial colonization and periodontal status in orthodontically treated patients. *Angle Orthod* 2005;**75**:227–232.
10. Burden DJ, Coulter WA, Johnston CD, Mullally B, Stevenson M. The prevalence of bacteraemia on removal of fixed orthodontic appliances. *Eur J Orthod* 2004;**26**:443–447.
11. Klukowska M, Bader A, Erbe C, Bellamy P, White DJ, Anastasia MK, Wehrbein H. Plaque levels of patients with fixed orthodontic appliances measured by digital plaque image analysis. *Am J Orthod Dentofacial Orthop* 2011;**139**:e463–470.
12. Erbe C, Klukowska M, Tsaknaki I, Timm H, Grender J, Wehrbein H. Efficacy of 3 toothbrush treatments on plaque removal in orthodontic patients assessed with digital plaque imaging: a randomized controlled trial. *Am J Orthod Dentofacial Orthop* 2013;**143**:760–766.
13. Smith RN, Brook AH, Elcock C. The quantification of dental plaque using an image analysis system: reliability and validation. *J Clin Periodontol* 2001;**28**:1158–1162.
14. Smith RN, Rawlinson A, Lath D, Elcock C, Walsh TF, Brook AH. Quantification of dental plaque on lingual tooth surfaces using image analysis: reliability and validation. *J Clin Periodontol* 2004;**31**:569–573.
15. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. *Am J Orthod Dentofacial Orthop* 1982;**81**:83–98.

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X-RAY ODDITIES

Many times, when we see in our practice a radiograph, we have the opportunity to note images that may or may not influence directly our diagnosis and our treatment plan.
This column of EJCO gives us the opportunity to show these images and to make some brief observations about them. The style is concise: the images largely speak for themselves.
Your suggestions for future topics as well as your comments will be very welcome.

The Kissing Molars

The patient was a woman aged 30 with a mutilated dentition, presenting the absence of various teeth and a Class II division 2 malocclusion.
The panoramic radiograph *(Fig. 1)* showed the complete inclusion of 18, 28, 48 and 33. It also revealed the impaction of second and third lower left molars, which shared the same follicular space. The occlusal faces of the two teeth were in contact with each other.

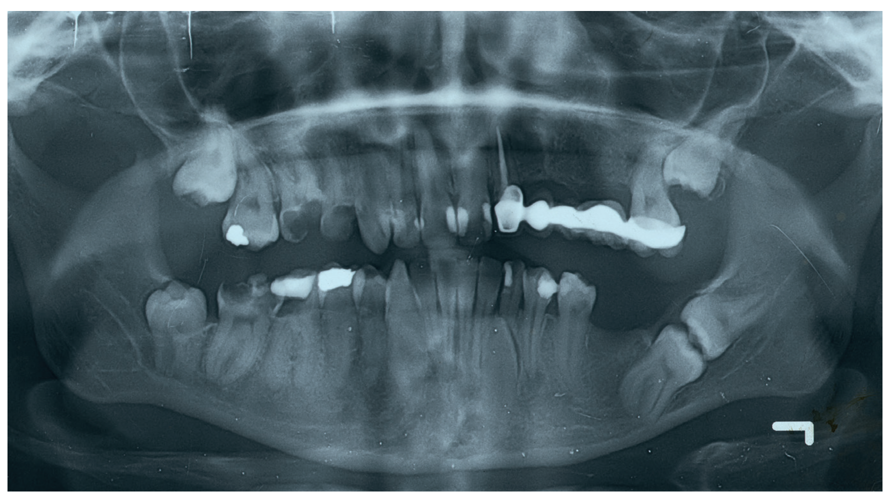

Figure 1. OPT showing a mutilated dentition with the inclusion of 18, 28, 48 and 33. 37 and 47 appear impacted and with the occlusal surfaces in contact.

OBSERVATIONS

The term 'kissing molars,' first described by R.F. Van Hoof in 1973[1], refers to contacting occlusal surfaces of the impacted permanent mandibular second, third and, very rarely, fourth molars.
It is an extremely rare condition.
Kissing molars have occlusal surfaces in close apposition in a single follicular space, with roots pointing in opposite directions[2-3-4].
Mammalian teeth develop from oral ectoderm and neural crest derived mesenchyme. The first morphological sign is the primary dental lamina from which the 20 buds of deciduous teeth develop. From primary dental lamina originates the secondary dental lamina from which the 20 buds of the monophisary permanent teeth develop.
First and second permanent molars develop from an accessory lamina that is a distal extension of the secondary dental lamina. The buds of third molars develop from the buds of second permanent molars at 4 years of age, so it is possible to hypothesize an anomaly in the embryonic development in the etiopathogenesis of the 'kissing molars'[5-6].
It is deemed to be appropriate to medically investigate muco-polysaccharidosis (MPS) in patients presenting with kissing molars as kissing molars have been linked to MPS[7].
Some Authors[8] recommend early surgical therapy as this condition can cause serious complications, including the formation of pathologies, such as dentigerous cysts or the destruction of the adjacent bone.

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REFERENCE LIST

1. Van Hoof RF. Four Kissing Molars. *Oral Surg Oral Med Oral Pathol* 1973;**35**:284
2. Shahista P, Mscarenhas R, Shetty S, Husain A. Kissing Molars: an unusal unexpected impaction. *Arch Med Health Sci* 2013;**1**:52-53
3. Krishnan B. Kissing Molars. *British Dental Journal* 2008;**204**:281-282
4. Boffano P, Gallesio C. Kissing molars. *J Craniofac Surg* 2009;**4**:1269-1270
5. De Felici M, Boitani C et al. Embriologia umana. *Piccin Editore*, Padova 2009
6. Thesleff I, Tummers M. Tooth organogenesis and regeneration (January 31, 2009), *StemBook, ed. The Stem Cell Research Community, StemBook*, doi/10.3824/stembook.1.37.1
7. Kiran HY, Bharani KS, Kamath RH, Manimangalath G, Madushankar GS. Kissing molars and hyperplastic dental follicles: report of a case and literature review. *Chin J Dent Res* 2014;**17**:57-63
8. Gulses A, Varol A, Sencimen M, Dumlu A. A study of impacted love: kissing molars. *Oral Health Dent Manag* 2012;**11**:185-8

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Cross-sectional Studies

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Prevalence: The proportion of a population with a specific condition (a disease or a risk factor) present in a given population at a defined time *(Table 1)*.

Incidence: The number of new cases that occur in a population at risk during a defined period of time.

Referring to our example, we analyse mouth breathers who do not present maxillary contraction; the same sample is re-evaluated after a specified time interval. The incidence risk is the number of persons who have developed maxillary contraction divided by the total number of participants in the study.

A cross-sectional study is an observational study in which the exposure and the outcome are determined at the same time in a given population. In previous articles I have explained the importance of the time factor in the classification of clinical trials and the definition of exposure and outcome[1].

Cross-sectional studies provide a "snapshot" of the frequency and characteristics of a disease or condition in a population at a particular point in time. They are usually carried out to assess the prevalence of an outcome in a given population and are therefore useful in the planning of public health interventions.

To assess the prevalence of a maxillary contraction in a population and its association with mouth breathing, we can use a cross-sectional study. Exposure is the presence/absence of mouth breathing and outcome is the presence/absence of maxillary contraction. We must take a representative sample of the larger population and assess mouth and nose breathing and diameter of the maxilla. The sample is then divided into two groups: "exposed" and "not exposed" (mouth breathers and nose breathers, respectively); in both groups, we look for the presence of maxillary contraction *(Table 1)*.

In this study the analysis of the association between exposure and outcome is limited by the fact that it is carried out at an exact point in time and it gives no indication of the sequence of events. Indeed, the prevalence of maxillary contraction may be both a cause and an effect of mouth breathing.

Cross-sectional studies, like all observational studies, are exposed to systematic errors (such as bias) and distortion of results due to the presence of confounding factors, which we will discuss in future articles.

	Outcome (maxillary contraction)	No outcome (correct transverse diameter)	Total
Exposed (mouth breathers)	a	b	a + b
Not exposed (nose breathers)	c	d	c + d

Table 1: Prevalence of maxillary contraction in mouth breathers= a/a+b
Prevalence of maxillary contraction in nose breathers= c/c+d

REFERENCE LIST

1. Oliva B. Introduction to clinical studies. *EJCO* 2014; **2**:63

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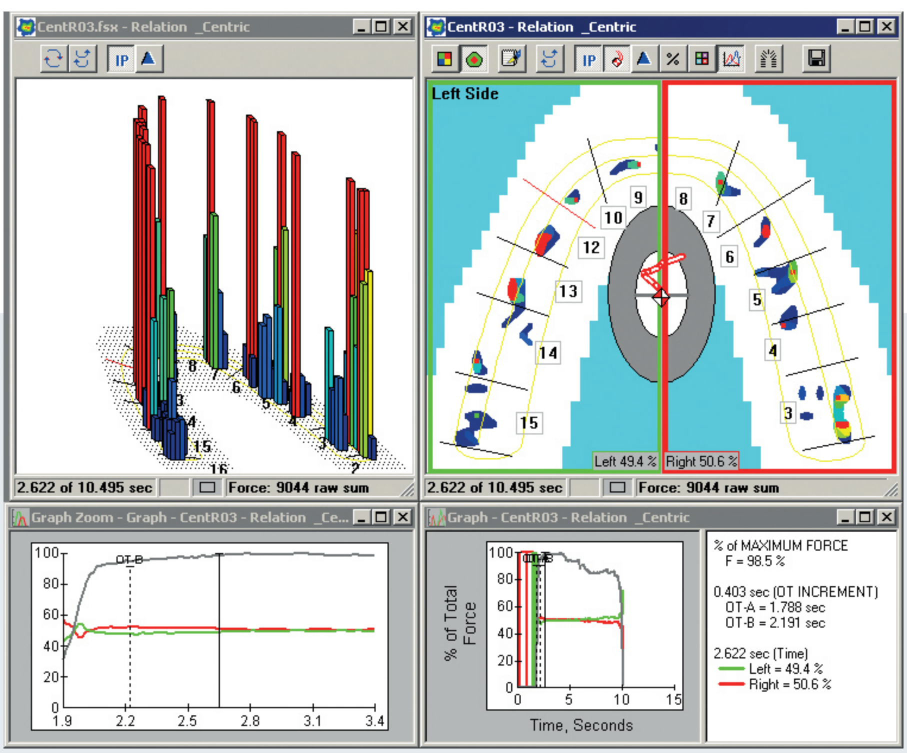
The T-scan

The T-scan is a leading technology in dentistry used to accurately measure the force and timing of occlusion. The hardware of this digital occlusal measurement system is comprised of a hand-held handle, which captures the data taken from the sensors and transfers it to a user interface, and a dental sensor, available in two sizes (small, large). The T-scan handle plugs into any USB port and can capture up to 685,000 contact points per second, while the T-scan sensors are reusable on a single patient, can be cold sterilized between patient visits, and are able to withstand 15-25 closures. Utilizing highly sophisticated software, the T-scan device records the patient's bite-force dynamics data in seconds, including

occlusal force, location and timing. It is well known that relying solely on articulating paper for determining occlusal force load can be misleading. However, clinicians using this advanced digital bite assessment tool can take advantage of the additional occlusal data provided, such as two- and three-dimensional representations of bite forces and timing information, and improve patient outcomes. Several features of the T-scan are also useful in patient education and communication, such as the three-dimensional force-view display and a colour code system showing bite force intensity. Thus, clinicians using the T-scan device can be sure that treatments to balance bite forces are carried out with greater precision and accuracy.



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