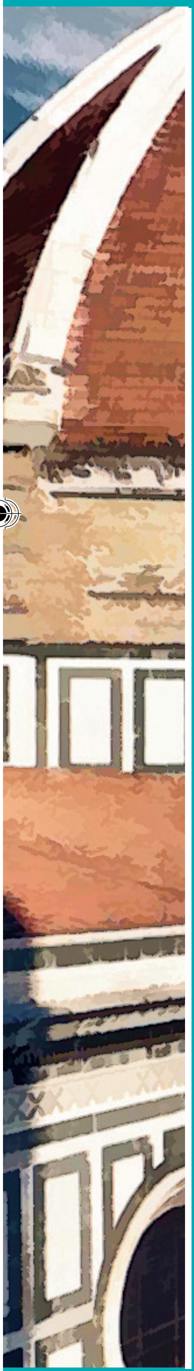
47th SIDO International Congress

“Patient-important outcomes in Orthodontics”

FLORENCE, 13-15 October 2016



Dear friend and participant,
it is a great pleasure to invite you to “Patient - important outcomes in Orthodontics”, the 2016 International SIDO Congress.
The letter “i” defines the meeting:

▶ ***‘Interactivity’***

Learning will be interactive, because participants can test their orthodontic expertise at the beginning of the meeting, select pertinent courses that address their knowledge gaps, and test their uptake of this knowledge at the end. Suggestions for courses that address similar clinical or research topics are listed online from March 15th 2016. Early birds with FADs packages will receive dedicated tutoring and will leave the congress with 50 CME.

▶ ***‘International’***

The meeting will be international, because speakers from all over the world will present their clinical experience and research findings. Eminent orthodontic speakers will share their long term findings and ideas on the future of orthodontics. We also offer a wide variety of pre-congress courses, which are promoted by the SIDO and sponsored by the Tweed Foundation, University of Connecticut, University of Aarhus and Boston University. AIOP, FEO, ORTEC, SIBOS and SITeBi are special partners and enrich the international flair.

▶ ***‘Innovation’***

*Innovation will also be a central theme. This meeting will address **(1)** the latest developments on modern digital diagnostics and digital tools **(2)** facts about acceleration of tooth movement and biomaterials **(3)** dealing with open bites, special tooth movements and solutions and **(4)** the latest in lingual appliances and aligners. AIOP has helped creating a very practical session on what is really important in ortho-pros cases.*

▶ ***‘Inspiration’***

Creating evidence-based knowledge on ‘patient important outcomes’ will be the key scientific objective.

Florence is always an inspiration and a historic backdrop to the congress in even years.
***Time to begin-** Join us on Thursday afternoon for a laid-back opening get-together with complimentary wine tasting at the Fortezza da Basso’s Caves and Bastions.*
***Time to explore-** Florence on Friday evening at the Galleria degli Uffizi: exclusively for SIDO the exquisite art and Botticelli’s Primavera in the company of friends at the President’s Reception.*

Be proud of being part of SIDO in 2016.

With great affection,

SIDO President
Silvia Allegrini

EDITORIAL

Clinical-based Evidence vs Literature-based Evidence

Raffaele Schiavoni
Editor-in-Chief

How to cite this article:
Schiavoni R. Clinical-based evidence vs literature-based evidence. *EJCO* 2016;**4**:33.

Evidence-based dentistry has definitely contributed to raising the bar in our profession. In fact, today no orthodontist would start treating their patient's malocclusion outside the guidelines established by the international literature. But here is where the problem lies: which literature?

In some cases, the international literature is contradictory, and in any case it doesn't always provide simple, univocal guidance. Furthermore, very often the literature is a "work in progress", but our patients have a problem "now"! Let's just consider the age-old question: "TMD and occlusion: does a link exist?". Shall we start an orthodontic treatment to solve a dysfunctional syndrome? The mushrooming of more-or-less "titled", online blogs has made things even more complicated by creating a sort of parallel information channel that cannot be ignored.

So we often find ourselves in front of patients who demand an orthodontic treatment to resolve problems like headaches, dizziness, back pain and fatigue. These chief complaints are rather atypical for our evidence-based profession. How should we behave in such cases? The ultimate goal of our profession is still to solve our patients' problems in the light of Hippocrates' principle: Primum non nocere.

Which stance should we take, given the risk of possible complaints in the case of "no result"? How should we reconcile the lack of evidence in the literature with the surprising clinical results obtained in many cases? The lack of evidence doesn't mean "evidence of a lack". Couldn't a cautious approach to these issues help research more than a stubborn "Non possumus"?

Greater focus on the link between occlusion and the TMJ should be a must in any orthodontic therapy and at any age, independently of any gnathological "belief". Certainly hiding oneself behind the obstinate conviction of the non-relationship between occlusion and TMD, repeating the same old adage 'stop talking about malocclusion' won't help advancement in our discipline.

What our discipline badly needs today is an extremely cautious, conscientious and professional approach. TM Graber in an editor's note to DG Woodside's article "The $4.4 Million Case" said: "It behoves the orthodontist to follow the fundamental risk-management procedures of informed consent, complete records, progress reports, and constant communication with patient, parents and referring dentists. All parties will benefit".

These words should be weighed and borne in mind every day in our profession – all parties will benefit!

doi:10.12889/10.12889/2016_A00252

Is the Shortest Distance Between Two Points a Straight Line?

Birte Melsen

Correspondence:
e-mail: birte@melsen.com

Article history:
Received: 17/05/2016
Published online: 03/06/2016

Conflict of interest:
The authors declare that they have no conflicts of interest related to this research.

How to cite this article:
Melsen B. Is the shortest distance between two points a straight line? *EJCO* 2016;**4**:34-39.

*“Birte Melsen doesn't need any kind of introduction.
Her reputation as a teacher and researcher is enormous in the orthodontic community.*

This article magistrally illustrates her thinking and the influence she had on the evolution of orthodontics in the last few decades.

Carlo Bonapace
Editor of the Who's Who column”

Abstract

My orthodontic training was a patchwork of available techniques aiming to achieve intra- and inter-arch displacements, all teaching the truth, but were they really scientifically based?
The treatments we perform are based on means of mechanical interaction with the periodontium. My knowledge regarding growth and bone, however, originated from the world of the bone biologists. Seeing orthodontics through the eyes of a bone biologist caused me a lot of frustration. Our journals are increasingly publishing papers describing evidence-based results, but the majority of these are focusing on the significant difference between mean values, while the variation within which we will find our patient is ignored. With a standard deviation 2-3 times larger than the mean difference, the clinical relevance is limited.
What is determining the treatments performed? Intensive marketing or the “truth” which has not been scientifically validated? Are the patients so different that all we can do is attempt to displace the teeth aiming for a reasonable goal?
Is “the shortest distance between two points is a straight line” the only science upon which our mechanics are based on?

Keywords
bone biology, orthodontics.

doi:10.12889/2016_C00254

Why dentistry?

It wasn't my dream to become a dentist. Nobody in our family had ever been to college and when I confronted my stepfather, a mink farmer, with my wish to study mathematics, his response was: "At least you should study something by which you can make a living". Dentistry was his recommendation. During the post-war period, money was scarce.

From dentistry to bone biology

So for me the choice was either study dentistry, or not study at all. Dentistry - to focus on one surface of one tooth - did not appeal to me. Fortunately I discovered that the Professor of Orthodontics looked at the patient and not at the single tooth. Orthodontics was an acceptable substitute for mathematics, which was my dream. Unfortunately, immediately after I had been accepted as a research associate at the Department of Orthodontics, Professor Harvold left for San Francisco. The professor in Anatomy therefore advised me to make contact Professor Bjørk in Copenhagen. At that department they had started a specialty in Orthodontics and Bjørk had become famous for his studies with indicators making it possible to distinguish between modelling of the bone (he called it remodelling) and displacements of bones during growth[1,2]. Of course these results were dependent on the stability of the reference structure used when superimposing the cephalograms. He asked me to perform a study verifying the stability of his reference structures. In those days we did not define the null hypothesis. The study had to be performed on human autopsy material and, as an ethical committee did not exist, I went to the Department of Pathology. Together with my husband, who was a medical student and the Professor of Pathology, we developed a method by which, when the skull was opened for examination of the brain, the excision remained invisible for those who would see the dead body following the autopsy. We included in the study all children between 0 and 18 years of age who had died without a diagnosis as a result of an accident. During my stipend period of 3 years we were able to include 126 individuals who presented a normal development[3].

The next problem was to learn the lab procedures related to histology and to prepare undecalcified sections. I also had to study bone biology and it was necessary to learn from the scientists focusing on bone.

I travelled to different bone research facilities. In Belfast, Scott[4] studied the facial skeleton and the influence of the nasal septum, Prichard[5] focused on bone and Latham performed experiments on chicken and rabbits to study growth centers and growth sites. In Minnesota, Jowsey[6] was using microradiography and in London Sissons[7], who was the bone pathologist at the Royal National Orthopedic hospital in London, had developed cutting and staining methods for the study of bone on undecalcified acrylic embedded sections, and Layon studied the effect of loading of bone on an animal model.

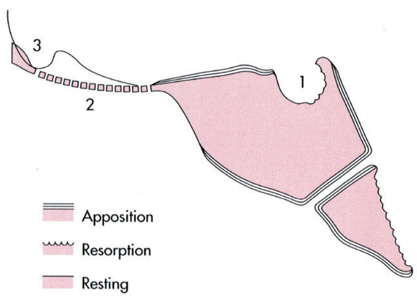
It was fascinating to meet these enthusiastic people involved in bone biology but actually far from the clinical side of orthodontics. When turning my focus back to orthodontics I learned that there was a deep breach between the way the orthodontists and bone biologists perceived bone and bone reaction.

Another problem was that histological sections were normally assessed by making a verbal description, but I wanted to perform a cross-sectional study and describe a pattern and therefore needed to develop a method for unbiased classification of the bony surfaces included in the cranial base.

My studies had brought me in contact with people from various aspects of research. Beni Solow[8], who was Associate Professor in Bjørk's department, shared my interest in mathematics and used the first computer in Demark to perform an epidemiological study of malocclusions as early as 1968. When we got a computer in Aarhus, I had the opportunity to take a course in programming and used ideas from Solow's work to combine the result from different methods for the classification of bony surfaces in an unbiased way. This was actually one of the first times, if not the first time, computers were used for data elaboration within medicine.

What I found was that the cranial base, although apparently stable, was maintaining its shape through a balance between modelling and displacement of the bones involved *(Fig. 1)*. The observation of the adaptation of morphology to function became clear to me when I compared the normal development with the results of either experimentally produced or pathology related alteration in either tissues or function. The bony adaptation both in morphology and density was fascinating.

My studies on human autopsy material continued and comprised



Source: Melsen B. The cranial base: The postnatal development of the cranial base studied histologically on human autopsy material. *Acta Odontol Scand* 1974;**32**:Supp. 62.

Figure 1: Diagramatic representation of the cranial base indicating the activity of the surfaces during growth. These activities disguise the displacement between the bones caused by growth in sutures and syncondrosis leaving the shape unaltered; apparently stable.

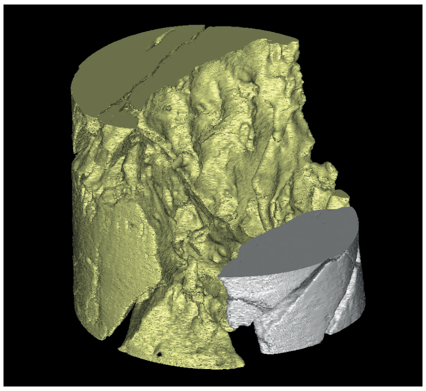


Figure 2: Micro CT of an alveolar wall illustrating the distinct irregularity of the so-called "wall". Provided by M. Dalstra

doi:10.12889/2016_C00254

description of the maxillary complex. The descriptions led to testing in animal models of hypotheses regarding factors of influence for the development.

Back to orthodontics

As my intention was to become an orthodontist, I had to add some clinical training to my education. As there was no formal education, a Tweed course was the first of a long series of courses, all of which claimed to teach the truth: Tweed, Begg, Jarabak, Gugino, Richetts, Woodside, Fränkel and Hilgers, just to mention a few. This was a world completely different from that of the bone biologists. Finally, I arrived in Minneapolis where they taught the Minnesota integrated technique, a clinical approach in which Isaacson had combined the best of a lot of "schools", among those, the segmented technique developed by Burstone[9-11]. I went to see Professor Burstone. He talked about forces and equilibrium. That made sense: only one force vector will lead to the goal. Once the tooth displacement was determined you could define the necessary force system[10,12]. Finally I could start working with applied mathematics.

Combining bone biology and orthodontics

Combining bone biology with clinical orthodontics was not easy. Even the language of the two worlds was different. The orthodontist only talked about remodelling and pressure and tension. The bone biologists differentiated between cortical and trabecular bone and between remodelling and modelling. The purpose of modelling is to adapt to changes in function, whereas the purpose of remodelling is primarily to maintain serum calcium level to about 10mg/dl, and secondarily to maintain strength by repairing micro-fractures occurring during function. Both types of bone undergo continuous renewal. 20-30% of trabecular bone is in remodelling per year whereas only 2-10 % of cortical bone is undergoing remodelling. The influence of function expressed as strain was described by Frost[13,14] in the "Mechanostat Theory" according to which lack of use leads to increased remodelling of bone. This increases porosity as seen in the alveolar bone surrounding teeth that are not in occlusion.

Orthodontists, when discussing tissue reaction related to tooth movement, talked about pressure and tension zone, whereas orthopedists and bone biologists focused on deformation. When loading a tooth, the orthodontists generated a pressure zone characterized by resorption, whereas orthopedists demonstrated increased bone density and thicker cortical bone when generating strain corresponding to mild overload. This corresponds to what we see in relation to bruxism and when training muscles in a fitness center. Osteocytes are receiving impulses from the deformation of the bone and there is no difference between tension and pressure. Cells react to a change in the strain values and bone adapts to the change. By using a different terminology most clinicians cannot communicate with bone biologists and although there are now many researchers within orthodontics who are working intensely in bone related research, most clinical and orthodontic textbooks still connect tooth movement with pressure and tension zones.

I tried to apply my knowledge of bone biology in a description of a new paradigm explaining the tissue reaction related to tooth movement. The increased remodelling observed with underloading could in fact be identical to the reaction seen in relation to what Reitan called direct resorption, whereas undermining or indirect resorption could be perceived as a repair of the local necrosis occurring as a result of the ischemia generated by the compression of the periodontal ligament[15]. The hypothesis formulated as the new paradigm was later supported by a finite element analysis where the periodontal ligament was modeled not as previously described as having linear properties, but more realistically with non-linear properties[16,17].

Controversies related to orthodontics

Another frustration originated in a term used by orthodontics: the "alveolar wall". When looking at it in large magnification it has nothing to do with a wall. It is more like an extremely irregular landscape *(Fig. 2)*[18,19]. Calculations of force levels in relation to wall area are therefore meaningless.

The controversies did not decrease when studying the literature on appliances. Fixed appliances are applying sliding mechanics and therefore most tooth movements are characterized by a certain resistance to sliding. Several papers and especially advertisements make resistance to sliding synonymous to friction, although a large number of valid research project have pointed out that friction is not identical to "resistance to sliding" but also comprise binding and notching. Nevertheless "friction free" brackets are still in the reference sphere of the orthodontists.

I never stop being surprised by the distance between science and the real world. The fact that appliances are in equilibrium is not taken into consideration and "faster" brackets are now on the menu. Analyzing the changes occurring during treatment of a growing patient, and most patients still belong to this category, it is amazing how small tooth movements achieved by the orthodontists are compared to growth-related changes. Nevertheless, shortening of treatment time is now the aim. The reason is most likely the increasing number of adult patients who want invisible and short treatments. Invisibility is taken care of by lingual appliances and various types of aligners. The background for the reduction in the duration of treatment is based on the findings by Frost who described RAP (regional acceleratory phenomena) as a reaction to a trauma; a healing characterized by an increased rate of bone turnover[14]. This began with corticotomies around the teeth to be moved. Other kinds of trauma have been suggested such as smaller interventions with piezo surgery or drilling of holes into the alveolar bone and, as an alternative, vibrations are claimed to speed up treatment.

Focusing on duration of treatment, it may seem strange that the difference between the turnover of trabecular and cortical bone is not taken into

doi:10.12889/2016_C00254

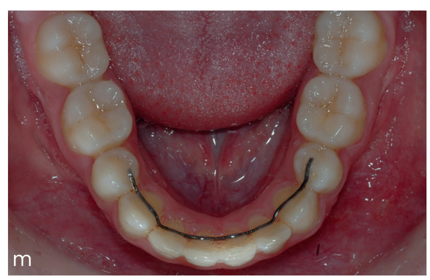


Figure 3: (a,b) Intraoral frontal and lateral view before treatment of a patient with agenesis of second premolars. (c-e) Intraoral views of the biomechanical system used for mesial displacement of the roots of 3.6. the movement of the roots is given by the activation in cross-over of 2 cantilevers in TMA® 0,017" x 0,025". A lingual ligature between the buttons has just been removed. (f,g) Following the removal of the mesial root of the deciduous molar the remaining mesial movement of the lower molars was performed with a 50 cN Sentalloy® spring, extending from a lever arm on the molars to the mini-implant inserted between the first premolar and the canine. A continuous arch wire in stainless steel 0,016" was used as a guide to avoid molar rotation. In the upper arch the deciduous molars have been extracted and the permanent molars were allowed to drift mesially. Thanks to occlusal anchorage, no skeletal anchorage was required. (h-m) Final occlusion.

consideration when planning the force system needed. Would it not be more logical to move the roots before crowns *(Fig. 3)*?
By doing so we not only could take advantage of the biological advantage of getting the roots moved into the extraction space before collapse of the alveolus, but also initiate the modelling of the cortical bone necessary for the adaptation of the alveolar process to the new tooth sequence.
We often start the treatment by levelling with a round leveling arch making the treatment more difficult as "good" teeth (that are in the correct position) and "bad" teeth (to be moved) are connected. Distinguishing between the active and the reactive unit would cut the treatment time considerably. Over the past decade skeletal anchorage has contributed to avoiding loss of anchorage, but in my opinion it

doi:10.12889/2016_C00254

is far too often used as a crutch to replace inadequate biomechanics. The affiliation of the orthodontists to a specific technique not only limits us in the application of new research but also reduces valuable interaction with colleagues from other specialties.
Orthodontists are focusing on techniques and prescriptions, often to the detriment of logical thinking. All our patients are different but this can not be only taken care of by individualized brackets. In patients where growth and functions are not our allies we need to take the individualized need into consideration, because there is only one correct force system for a specific displacement. We have to define the treatment goal, define the necessary force system and then construct a custom-made appliance *(Fig 4)*. If we don't benefit from research performed by the bone biologists and the engineers, orthodontics will, rather than being a scientifically based profession, end up an adjunct to cosmetics performed by less skilled personnel.

Figure 4: (a,b) Intraoral occlusal and frontal view of a degenerated dentition with significant displacement of the upper right incisors related to a severe periodontitis, which had been treated but a severe marginal bone loss persisted.
(c,d) The active unit, the teeth to be displaced were consolidated as one tooth that was rotated clockwise, intruded and mesially rotated around a center localized at the contact point between the right lateral incisor and the right canine. The reactive unit comprised all the other teeth that were consolidated with two transpalatal arches. The resistance of the reactive unit was further reinforced by occlusal on-lays made by bonded composites.
(f) Following the predicted displacement of the two incisors the upper arch could be finished in a straight wire. The lower arch was treated in a continuous arch to a compromise. The lower midline could not be corrected as there was no buccal bone present on the labial aspect of the right lower canine.
(e) Occlusal view of the finished result which was maintained by a cast lingual retainer ensuring the optimal transfer of occlusal forces to the incisors characterized by a significant apical marginal displacement of the marginal periodontium.
(g-i) Finished result.
Cases treated at the Department of Orthodontics, University of Aarhus, Denmark.

doi:10.12889/2016_C00254

REFERENCE LIST

1. Bjork A, Skieller V. Facial development and tooth eruption. An implant study at the age of puberty. *Am J Orthod* 1972;**62**:339-383.
2. Bjork A, Skieller V. Growth in width of the maxilla studied by the implant method. *Scand J Plast Reconstr Surg* 1974;**8**:26-33.
3. Melsen B. The cranial base: The postnatal development of the cranial base studied histologically on human autopsy material. *Acta Odontol Scand* 1974;**32**:Supp. 62.
4. Scott JH. *Dento-facial Development and growth*. 1 ed. Oxford: Pergamon press, 1967.
5. Pritchard JJ. The structures and development of cranial face and sutures. *J Anat* 1956;**90**:73-86.
6. Jowsey J, Phil D, Kelly PJ et al. Quantitative Microradiographich studies of normal and osteoporotic bone. *J Bone Joint Surg Am* 1965;**47**:785-806.
7. Sissons HA. Intermittent periosteal activity. *Nature* 1949;**163**:1001.
8. Solow B, Helm S. A method for computer analysis of epidemiological malocclusion data. *Acta Odontol Scand* 1968;**26**:63-88.
9. Burstone CJ. Rationale of the segmented arch. *Am J Orthod* 1962;**48**:805-822.
10. Burstone CJ. The mechanics of the segmented arch techniques. *Angle Orthod* 1966;**36**:99-120.
11. Isaacson RJ, Lindauer SJ, Davidovitch M. On tooth movement. *Angle Orthod* 1993;**63**:305-309.
12. Burstone CJ, Koenig HA. Force systems from an ideal arch. *Am J Orthod* 1974;**65**:270-289.
13. Frost HM. Perspectives: bone's mechanical usage windows. *Bone and Mineral* 1992;**19**:257-271.
14. Frost HM. Bone's mechanostat: a 2003 update. *Anat Rec A Discov Mol Cell Evol Biol* 2003;**275**:1081-1101.
15. Melsen B. Biological reaction of alveolar bone to orthodontic tooth movement. *Angle Orthod* 1999;**69**:151-158.
16. Cattaneo PM. *Orthodontic Aspects of Bone Mechanics and Bone Remodelling* University of Aarhus; 2003.
17. Cattaneo PM, Dalstra M, Melsen B. The finite element method: a tool to study orthodontic tooth movement. *J Dent Res* 2005;**84**:428-433.
18. Dalstra M, Cattaneo PM, Beckmann F., Melsen B. Synchrotron radiation-based micro-tomography of alveolar support tissues. *Orthod Craniofac Res.* 2006;**9**:199-205.
19. Dalstra M, Cattaneo PM, Laursen MG, Beckmann F, Melsen B. Multi-level synchrotron radiation-based microtomography of the dental alveolus and its consequences for orthodontics. *J Biomech* 2015;**48**:801-816.
20. Frost HM. Wolff's Law and bone's structural adaptations to mechanical usage: an overview for clinicians. *Angle Orthod* 1994;**64**:175-188.

doi:10.12889/2016_C00254

CLINICAL ARTICLE

Corticotomy-assisted Implant-anchored Molar Intrusion for Enhancement of Orthognathic Surgery Results in Patients with Hemimandibular Hyperplasia

Simonas Grybauskas
Oral and Maxillofacial surgeon
Vilnius University Zalgirio clinic, Vilnius, Lithuania
Lithuanian University of Health Sciences, Kaunas, Lithuania

Dalia Latkauskiene
Specialist Orthodontist
Lithuanian University of Health Sciences, Kaunas, Lithuania

Correspondence:
e-mail: simonas.grybauskas@gmail.com

Article history:
Received: 30/11/2014
Accepted: 31/03/2016
Published online: 31/05/2016

Conflict of interest:
The authors declare that they have no conflicts of interest related to this research.

How to cite this article:
Grybauskas S, Latkauskiene D. Corticotomy-assisted implant-anchored molar intrusion for enhancement of orthognathic surgery results in patients with hemimandibular hyperplasia. *EJCO* 2016;**4**:40-48.

Abstract

Objectives: Vertical skeletal facial asymmetries caused by hemimandibular overgrowth often result in compensatory dentoalveolar elongation on the affected side. Surgical leveling of dental arches during orthognathic surgery results in incomplete correction of the lower jaw asymmetry and necessitates further simultaneous surgical procedures, such as lower border ostectomy, inferior alveolar nerve lateralization, and grafting.

Materials and methods: We present a novel technique for the vertical decompensation of dentoalveolar processes to improve orthognathic surgery outcomes. The technique consists of installing skeletal anchorage into the upper and lower jaws, corticotomies of the alveolar processes, and skeletally-anchored orthodontic molar intrusion by means of custom-made intrusion frameworks. The resultant unilateral posterior open bite enables larger rotation in the frontal plane during surgical repositioning of the lower jaw.

Results: A 27-year-old woman with hemimandibular hyperplasia and compensatory elongation of the dentoalveolar processes was scheduled for orthodontic-orthognathic treatment. Four months of surgically-assisted intrusion resulted in a 7 mm unilateral posterior open bite. Two-piece Le Fort I osteotomy, bilateral sagittal split osteotomy (BSSO), condylectomy, genioplasty, and minimal lower border contouring were performed during a single-stage surgery.

Conclusions: Surgically-assisted implant-anchored intrusion of the molars is a feasible technique for vertical pre-surgical decompensation in vertical skeletal asymmetries. The degree of unilateral posterior open bite achieved is essential for surgical planning since rotation of the mandible in the frontal plane reduces the degree of lower border ostectomy.

Keywords
Molar intrusion, corticotomy, skeletal anchorage, hemimandibular hyperplasia

doi:10.12889/2016_C00248

INTRODUCTION

As suggested by *Obwegeser*, condylar growth hyperactivity has several clinical manifestations: Type I or hemimandibular hyperplasia (HH), Type II or hemimandibular elongation (HE), and Type III or a hybrid form of HH and HE[1].

Type I is characterized by three-dimensional increase of mandibular volume on the affected side in all sections up to the symphysis. However there is neither deviation of the symphysis to the contralateral side nor cross-bite. Type II is characterized by elongation of all sections of the affected side of the mandible which results in chin displacement to the contralateral side and occurrence of cross-bite. There is no increase in volume of the affected side. Type III is characterized by a more voluminous and elongated affected side of the mandible with chin displacement to the contralateral side. It is a mixed form of HH and HE[1].

Condylar hyperplasia can be produced by HH and hybrid forms but not by HE, however condylar tumour-like enlargement may appear without manifestation of HH or HE features. Once condylar hyperplasia appears as a result of HH, it results in an increased volume of all segments of half of the mandible which is not typical of condylar hyperplasia of any other origin. Typical clinical features of HH are:

- increased height and medial shift of the affected side of the mandible;
- shortened and laterally shifted contralateral side of the mandible,
- elongation of the maxillary and mandibular alveolar processes on the affected side;
- tilting of occlusal plane and lip commissure;
- compensatory downward growth of maxilla and sinus on the affected side;
- bowing down of the lower border with low running mandibular canal, and affected gonial angle rounded off and in a more caudal position;
- rotation of the occlusion in the vertical and axial planes;
- rare occurrence of cross-bite unlike in HE.

The surgical-orthodontic treatment of patients with HH usually includes maxillomandibular osteotomies, lower border reshaping, genioplasty and condylectomy. In growing patients a high condylectomy may be sufficient to control the abnormal growth pattern and normalize the development between the two sides of the mandible once the hypervascularized layer of the hyperplastic condyle is removed. In adult patients however, low condylectomy may be needed if the pathologic growth has expanded to the entire condylar volume. In mild HH cases a conservative approach, such as "wait and see", may be used. However, care must be taken if the patient has consented to orthognathic surgery, since the slow growing condyle may gradually affect the final facial and occlusal features after orthognathic surgery.

Although the clinical signs of the three types of condylar hyperactivity are different, abnormal elongation of

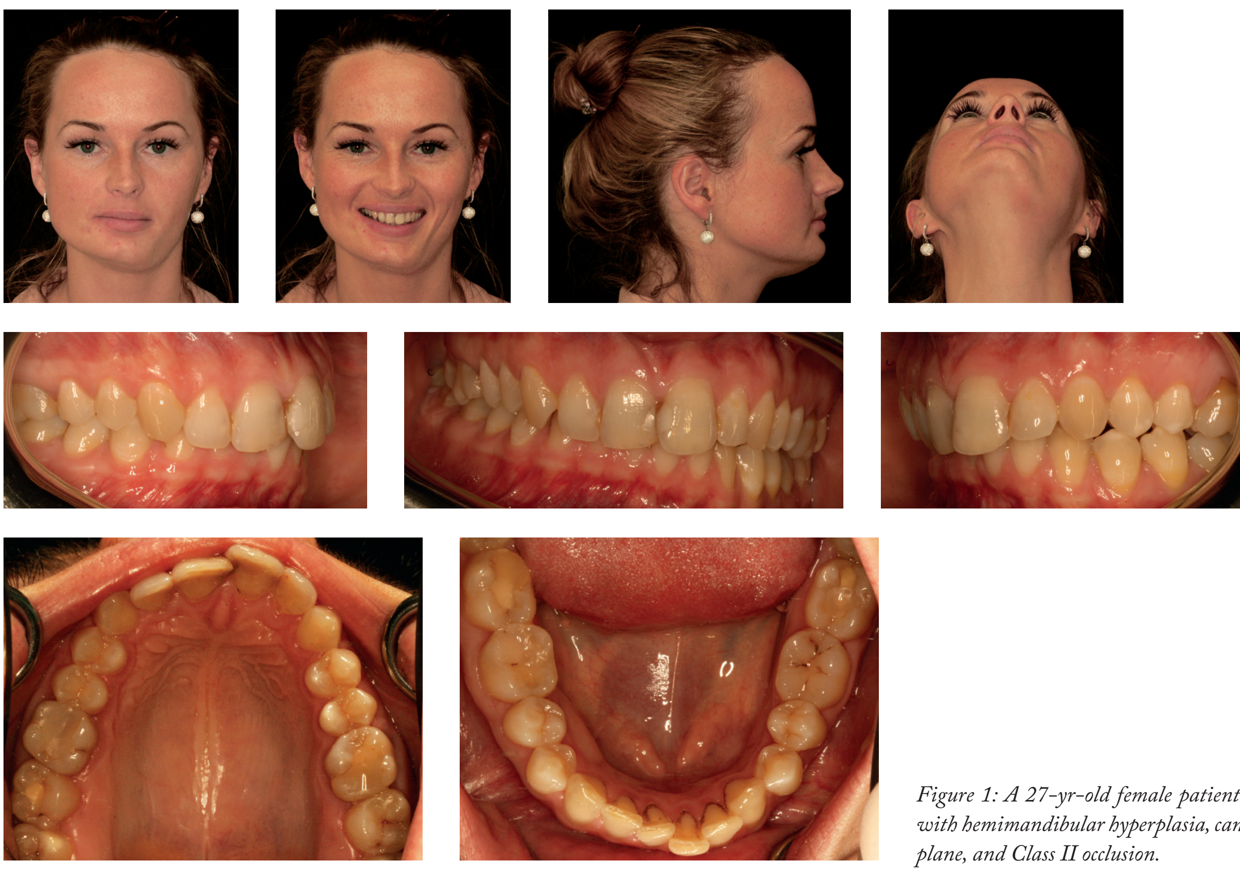


Figure 1: A 27-yr-old female patient presenting with hemimandibular hyperplasia, canted occlusal plane, and Class II occlusion.

doi:10.12889/2016_C00248

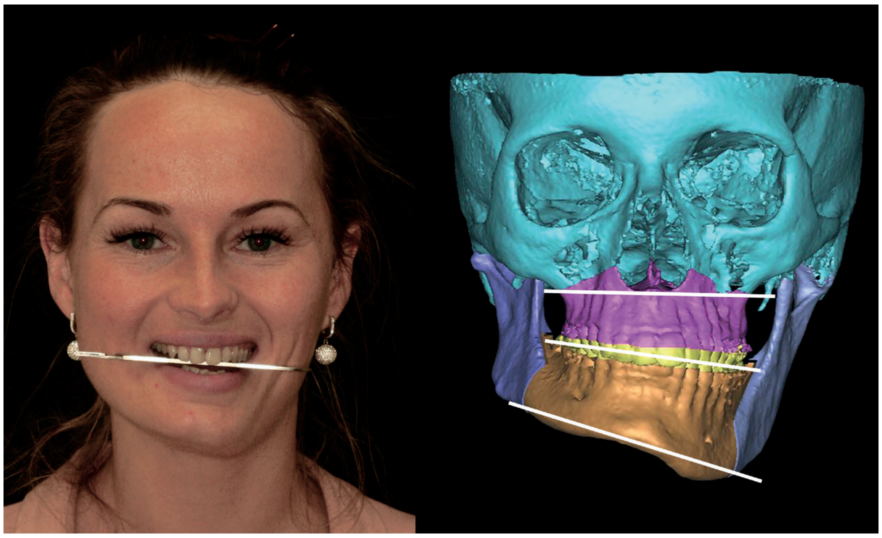


Figure 2: The relationship between the occlusal plane and skeletal bases of the maxilla and mandible.

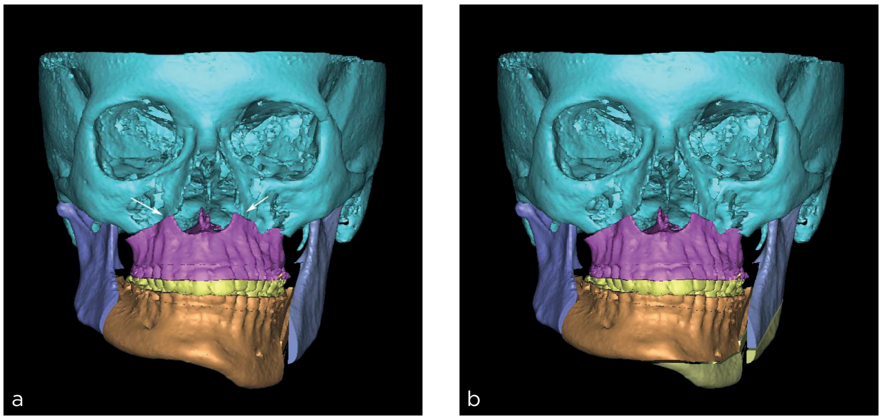


Figure 3: Virtual simulation of surgery by use of SimPlant 13.0 software: a) Simulation of a single-stage orthognathic surgery with maxillomandibular rotation in the frontal plane, highlighting the risk of resulting midfacial skeletal asymmetry. b) Extensive ostectomy at the lower border would be required to correct lower facial asymmetry.

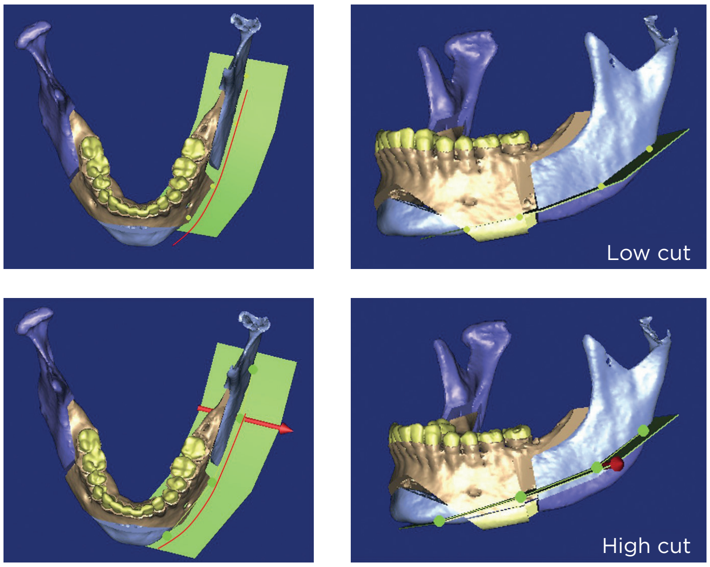


Figure 4: The impact of the amount of lower border ostectomy on the morphology of the mandibular body. A higher osteotomy line results in a thinner mandibular body.

the affected ramus is common to all three[1].

The effect of hemimandibular hyperactivity on the morphology of alveolar process

Elongation of the ramus during abnormal hemimandibular overgrowth results in vertical asymmetry of the gonial angles and canting of the skeletal base of the mandible *(Fig. 1)*. Subsequently, the alveolar process, which is a part of the lower jaw, often also becomes canted. However, due to abnormally slow skeletal growth, compensatory changes usually take place in the upper and lower dentoalveolar processes, such as elongation and supra-eruption of teeth on the affected side. The upper occlusal plane becomes canted, and the lower occlusal plane cant decreases. As a result of this compensatory action, the occlusal plane inclination in the frontal plane differs from the inclination of the skeletal bases of the maxilla and the mandible *(Fig. 2)*[2].

The implication of vertical compensations on surgical planning

Planned orthognathic surgery should be considered for compensatory growth in the alveolar process because the occlusal plane is not parallel to the skeletal bases of the jaws. The decision to level the skeletal base of the lower jaw can lead to a severe cant in the lower occlusal plane, requiring a more aggressive surgical leveling of the upper occlusal plane and resulting in a canted smile that is not aesthetically acceptable.

One of the main goals of surgical treatment is to level the lower and upper occlusal planes. This requires impaction of the upper jaw on the elongated side as well as rotation of the lower jaw in the frontal plane to reduce the lower cant. However, such surgical repositioning can lead to skeletal asymmetry of the upper jaw, which was symmetrical before surgery *(Fig. 3a)*. To prevent this, some reports recommend using mini-screw anchorage for orthodontic leveling of the upper occlusal plane by unilateral intrusion of the upper molars, and limiting surgical intervention to the lower jaw[3,4]. Moreover, the skeletal

doi:10.12889/2016_C00248

base of the lower jaw is under-corrected in the frontal plane since elongation of the alveolar process does not allow a sufficiently large rotation of the skeletal base. Therefore, the skeletal vertical asymmetry of the teeth-bearing fragment would remain under-corrected unless a lower border resection is performed on the affected side *(Fig. 3b)*[5,6]. Resection and reshaping of the lower border is a safe and simple procedure; however, if a large fragment needs to be resected, the cutting line can run into the mandibular canal, requiring inferior alveolar nerve (IAN) lateralization prior to resection[7]. Moreover, the higher the cutting line, the thinner the remaining mandibular body, resulting in asymmetry in the axial plane *(Fig. 4)*.

Rationale for molar intrusion on the elongated side

Taken together, the abovementioned considerations suggest that the surgical treatment plan can be simplified if the upper occlusal plane is leveled to the maxillary skeletal base, and if the lower occlusal plane is subsequently leveled to the mandibular skeletal base. This can be achieved by regulating the heights of the dentoalveolar processes and by parallelizing the occlusal planes to the skeletal bases, i.e. intrusion of teeth on the elongated side and extrusion of teeth on the short side. The resulting posterior open bite is then used for surgical leveling of the lower dental arch in the frontal plane, thus correcting both the occlusal plane and the skeletal base. Equilibration of the height of the lower alveolar processes between both sides reduces the need or amount of contourplasty on the affected side of the mandible.

Compared to extrusion, intrusion of teeth has been reported to cause about four times more root resorption[8]. According to different sources, intrusive movement during orthodontic treatment is the primary predictive factor for external apical root resorption[9,10]. In addition, some studies revealed that the extent of root resorption varies with the magnitude of the applied intrusive force[11,12].

To maximize the size and speed of intrusion, corticotomies can be incorporated as a valuable addition to orthodontic mechanics.

Anchorage for intrusion

One of the most challenging problems in orthodontics is to find sufficient anchorage to permit the expected teeth movements. To avoid buccal-lingual tilting of the posterior teeth, anchorage units need to be constructed from both sides. In the upper jaw, buccal anchorage can be created by placement of a "Bollard with Hook'" plate (Tita-Link, 2, av. de Hinnisdael, 1150 Brussels, Belgium; www.tita-link.com) in a standardized way as previously described[13]. Bollard miniplates appear to be reliable anchorage, with a reported overall success rate of 97% in terms of stability[14]. Miniplates present an advantage because the fixation screws are generally placed apically to the roots and, therefore, do not interfere with tooth movement because the roots can easily slide past the anchorage device[15-17]. In the present case, two miniscrews were incorporated into the paramedian anterior palate to create palatal anchorage in the maxilla. *Karagkiolidou et al.* examined the overall success of miniscrews inserted into the paramedian palatal region for the support of various appliances during orthodontic treatment, and showed excellent overall survival of the miniscrews (97.9%)[18]. In the lower jaw, a conventional dental implant (BioHorizons, 2300 Riverchase Center, Birmingham, AL 35244, USA) was placed into the retromolar area, which supported a custom-made casted construction for both lingual and buccal anchorage two months after implant placement.

Our proposed combined orthodontic-surgical treatment protocol for the correction of the cant of the occlusal planes and the skeletal and esthetic features of this particular case of Type I condylar hyperactivity (HH) consists of:

- installation of skeletal anchorage devices: miniscrews, bollard plates, and dental implants;
- corticotomy-assisted implant-anchored intrusion of the posterior teeth on the affected side;
- orthodontic decompensation of upper incisor inclinations to enable Class I occlusion;
- orthognathic surgery, contourplasty, and soft tissue suspension;
- orthodontic treatment and retention.

MATERIALS AND METHODS

The sequence of clinical steps:

Step 1. Place dental implant in the area of the wisdom tooth. If the wisdom tooth has not been removed, remove it and allow at least three months for the bone to heal before placing the dental implant.

Step 2 *(two-three months after Step 1).* If the implant has been submerged, place a healing abutment at this stage.

Step 3 *(one-two weeks after Step 2).* Place palatal miniscrews and take pickup impressions of the lower and upper dental arches. Custom-made intrusion frameworks and splint for upper posterior teeth on the affected side should be ordered from the laboratory.

Step 4 *(can be performed immediately following the previous step).* Perform corticotomies and insert a bollard plate in the posterior maxilla. The bollard plate can also be inserted during Step 1.

Step 5 *(two weeks after Step 4).* Fix the intrusion frameworks for the implants and insert the splint. The intrusion process can then be initiated.

Preparing units for anchorage

Upper jaw vestibular anchorage. The surgical protocol for the installation of bollard plates has been described by *Cornelis et al.* (www.tita-link.com/publications-and-events)[19]. The miniplate is inserted under local anesthesia during corticotomy surgery.

Upper jaw palatal anchorage. Two Ortho Easy miniscrews 1.7 mm x 10 mm (Forestadent, 2315 Weldon Parkway, St. Louis, MO 63146, USA; www.forestadent.com) were placed in the anterior palate, approximately 8 mm behind the papilla incisive, two weeks before loading. A pickup impression of the maxillary arch together and of the abutments secured on the implants was

doi:10.12889/2016_C00248

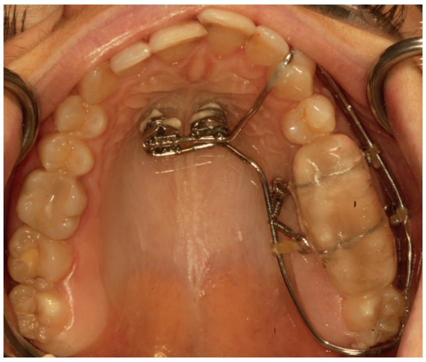


Figure 5: Intrusion anchorage skeletally fixed by two palatal implants and a bollard plate.

Figure 6: Intrusion anchorage skeletally supported by a conventional implant in the retromolar region.

Figure 7: Intrusion splint for the upper molars. The eyelets were designed to facilitate intrusion by attached elastics.

taken immediately after placement. The anchorage bar was bent in the laboratory out of a stainless steel wire (diameter 1.1 mm) and welded to both the abutments. The construction was snapped over the palatal miniscrews, and secured with the Fuji plus luting cement, one week after implants were placed *(Fig. 5)*.

Lower jaw anchorage. A short conventional dental implant of 3.5 mm × 9 mm (BioHorizons, 2300 Riverchase Center, Birmingham, AL 35244, USA; www.biohorizons.com) was placed in the area of the wisdom tooth. Two months later, an impression of the lower arch was taken to produce a casted framework for intrusion of the lateral segment. Construction was fixed on the implant by a prosthodontist two days before loading *(Fig. 6)*. An additional mini-screw was placed between the premolars.

Anchorage on the upper and lower posterior teeth. One week before corticotomy surgery, an alginate impression of the upper jaw was taken to produce the partial splint. The splint was cemented with Ketac-Cem glass-ionomer cement (3M Oral Care , 2501 Hudson Rd, St Paul, MN 55144, United States; www.3m.com/3M/en_US/dental-us) onto the upper posterior teeth subject to intrusion. Special eyelets were constructed in the splint to attach the chain to both the buccal and palatal anchorage *(Fig. 7)*. In the lower arch, the chain outstretched through the interdental spaces. To support the chain, a wire Bond-A-Braid® (Reliance Orthodontic Products, 1S440 W Thorndale Ave, Itasca, IL 60143, United States; www.relianceorthodontics.com) was bonded on the occlusal surfaces of the teeth undergoing intrusion.

Corticotomies

Vestibular and palatal/lingual corticotomies in the upper and lower alveolar processes were performed on the same day two weeks before the start of intrusion.

Upper jaw: full thickness vestibular and palatal flaps were raised and a piezoelectric saw was used to cut through the cortical bone between the teeth from the vestibular and palatal sides. Horizontal cuts through the entire cortex were made 5 mm away from the teeth apices *(Fig. 8a)*. A bollard plate was fixed above the horizontal corticotomies, and vestibular miniscrews, which had been used during a failed attempt to intrude the molars without corticotomies, were removed. Thin alveolar bone areas were covered with bovine derived particulate bone Bio-Oss (Geistlich Pharma AG, Bahnhofstrasse 40 6110 Wolhusen, Switzerland; www.geistlich-pharma.com), and flaps were sutured back to the initial position.

Lower jaw: intrasulcular incisions were made and full thickness flaps were raised to expose the alveolar process on both sides. Corticotomy cuts were made according to the same protocol used for the upper jaw *(Fig. 8b)*. The horizontal cuts were made with caution since the bone below the apices was thick. The location of corticotomies as well as the position of the bollard plate and the dental implant are indicated with arrows on the postoperative cone-beam computed tomography (CBCT) scan *(Fig. 9)*. Stitches were removed seven days after surgery.

Hygiene and pharmaceuticals. The patient was instructed to brush the anchorage devices at least twice a day. Chlorhexidine mouth rinses were recommended during the first week after placement. No antibiotics were prescribed.

Loading. Anchorage constructions were loaded approximately two weeks after corticotomy surgery and two and a half months after placement of the dental implant. Force was delivered via elastic chain traction (Rocky Mountain Orthodontics, 650 W Colfax Ave, Denver, CO 80204, United States; www.rmortho.com). The chain was changed every two weeks until the desired intrusion was achieved. Furthermore, occlusal forces were utilized to achieve increased intrusion since the bite was raised on the 2 mm thickness splint. Occlusal forces resulted in additional intrusive mechanics on the working side. Spontaneous extrusion of the teeth on the contralateral side was enabled simultaneously due to the resultant open bite *(Fig. 10)*.

Follow-up and minimal pre-surgical orthodontics. Four months after surgery, the average intrusion of the molars in the upper and lower dental arch was 3 mm and 4 mm, respectively. The resultant unilateral posterior open bite was 7 mm *(Fig. 11)*. Intrusion was therefore deemed satisfactory. A removable splint was placed to maintain the acquired space *(Fig. 12)*. Diagnostic casts were used to predict the fit of dental arches at surgery. Upper fixed appliances were bonded to align the upper dental arch

doi:10.12889/2016_C00248

Figure 8: Corticotomy cuts in the upper jaw (a) and in the lower jaw (b) were performed in the area of the premolars and molars on both sides.

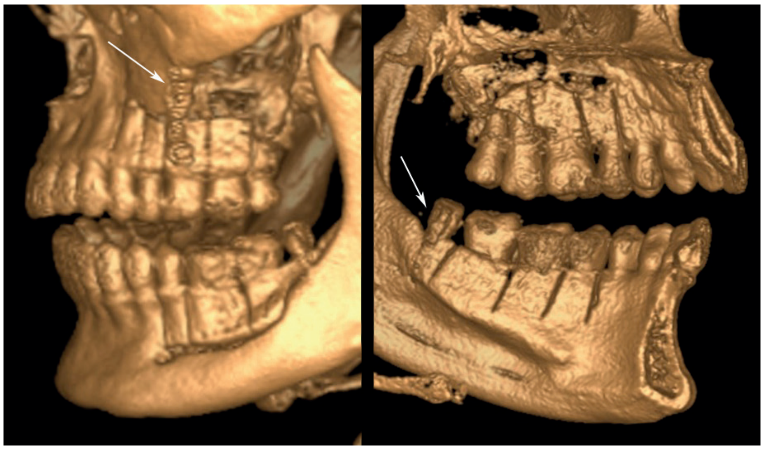


Figure 9: Postoperative CBCT scan. Arrows indicate the location of the bollard plate and the dental implant.

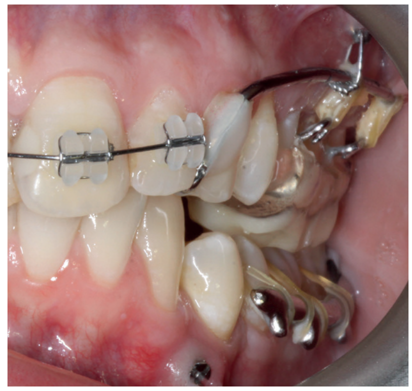


Figure 10: Upper and lower intrusion devices were functional four months post-implantation. Additional acrylics were gradually added to the intrusion splint to maintain the occlusion raised on the left side.

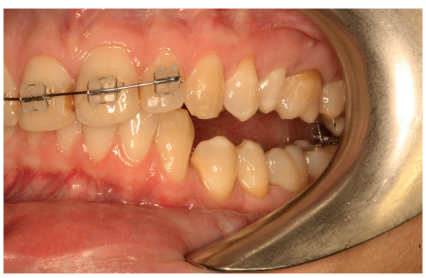


Figure 11: Occlusion after the end of the intrusion process demonstrating a 7 mm unilateral posterior open bite.

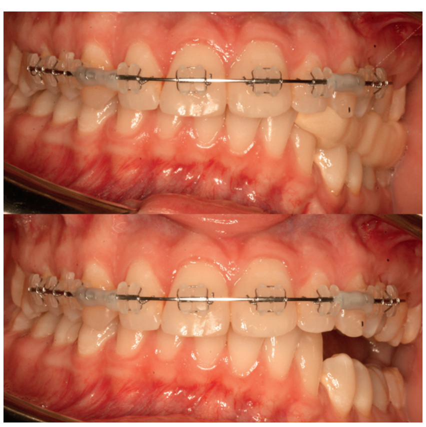


Figure 12: A retention splint was used to retain the space while minimal pre-surgical orthodontics was conducted.

and procline the upper front teeth. Victory Low Profile 022 slot brackets (3M Unitek Orthodontic Products, 2724 South Peck Road, Monrovia, CA 91016, USA; solutions.3m.com) were bonded on the upper dental arch. The wire sequence was as follows: initial alignment - 016 Niti Sentalloy wire (Dentsply GAC, 355 Knickerbocker Ave, Bohemia, NY 11716, USA; www.dentsply.com), progressed with 16/22 Niti and 18/25 NiTi wire. Spaces approximately 1.5 mm wide were opened on 18/25 stainless steel wire using closed coil NiTi spring (Dentsply GAC) between the lateral incisors and canines in order to further increase the anterior tooth mass *(Fig. 14)*. The opened spaces enabled placement of dental arches in Class I occlusion at the time of orthognathic surgery. The retention splint was worn 24/7 before surgery to retain the intrusion outcome. Lower Victory Low profile braces were bonded just before surgery, but no wire was inserted. Facial appearance and occlusal setup are presented in *Fig. 14*.

Surgery

Virtual surgical simulation was performed with SimPlant 13.0 software (Materialise, Technologielaan 15, 3001 Leuven, Belgium; www.materialise.com). The single-stage surgery consisted of the following steps *(Fig. 15)*:

1) two-piece Le Fort I osteotomy. Segmentation behind the right lateral incisor was performed to correct the break in the occlusal plane. Left cheekbone augmentation was then performed;
2) bilateral sagittal split osteotomy (BSSO) of the mandible;
3) left condylectomy (removing 20 mm of the condyle);
4) left lower border resection of 5 mm;
5) BSSO osteosynthesis.
6) soft tissue suspension on the left;
7) downgrafting genioplasty.

Postsurgical follow-up. The immediate postoperative occlusion is presented in *Fig. 16*. Alignment of the lower dental arch was initiated three weeks after surgery by inserting a 016

doi:10.12889/2016_C00248

Niti Sentalloy wire (Dentsply GAC). Postoperative occlusion was Class I with good transversal dimension of the dental arches. Follow-up orthodontic treatment included alignment of the lower dental arch, closing the spaces in the upper dental arch and settling occlusion *(Fig. 16)*. Conventional orthodontics was completed in twelve months after surgery. Fixed upper/lower retainers were bonded and removable Hawley type plates were fitted to achieve the final result. Final treatment outcomes one year after surgery are shown in *Fig. 17*. CBCT scans before treatment and at ten months after surgery are presented in *Fig. 18*. Ortopantomograms before molar intrusion, during molar intrusion, before and at ten months after orthognathic surgery are presented in *Fig. 19*.

Due to low condylectomy, the patient experienced a significant lower jaw deviation to the left upon mouth opening during the first months after surgery. She started jaw excercises at three weeks after surgery and continued with physical therapy throughout the entire postoperative period. One year after surgery, there is a minimal deviation upon mouth opening. This is not noticed by the patient and does not cause functional problems that need to be addressed.

CONCLUSIONS

Surgically-assisted implant-anchored intrusion of the molars is a feasible technique for vertical decompensation of vertical dento-skeletal asymmetries and leveling of canted occlusal planes to the skeletal bases. The amount of open bite achieved during intrusion is essential for surgical planning, since a larger unilateral posterior open bite on the affected side allows surgical repositioning of the lower jaw with rotation in the frontal plane and reduces the need or amount of lower border ostectomy. Further investigations are needed in more patients to draw stronger conclusions.

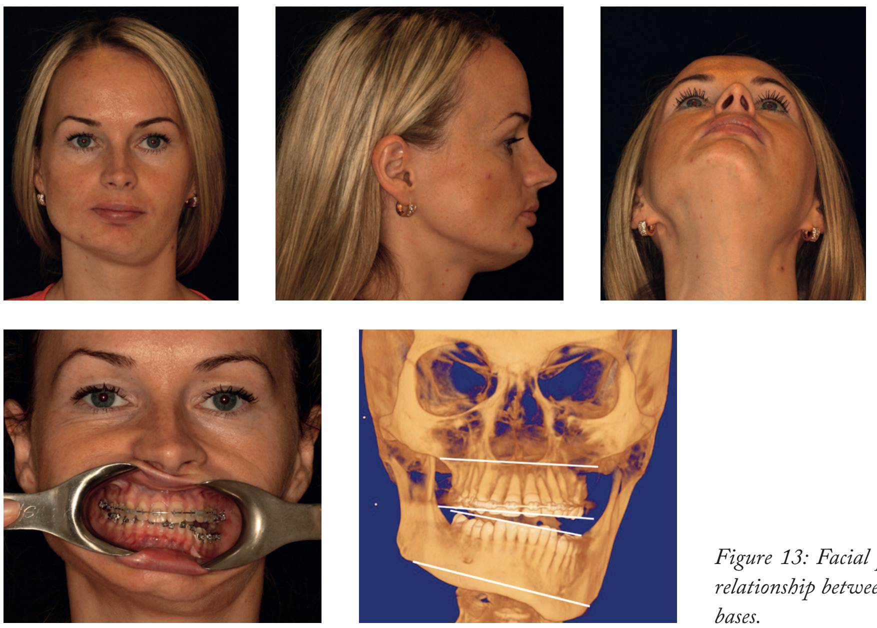


Figure 13: Facial photographs before orthognathic surgery showing the relationship between the upper and lower occlusal planes and the skeletal bases.

Figure 14: The upper front teeth were proclined, and additional spaces were opened behind the lateral incisors for correction of tooth-size discrepancy and for placement of the dental arches into Class I at the time of surgery.

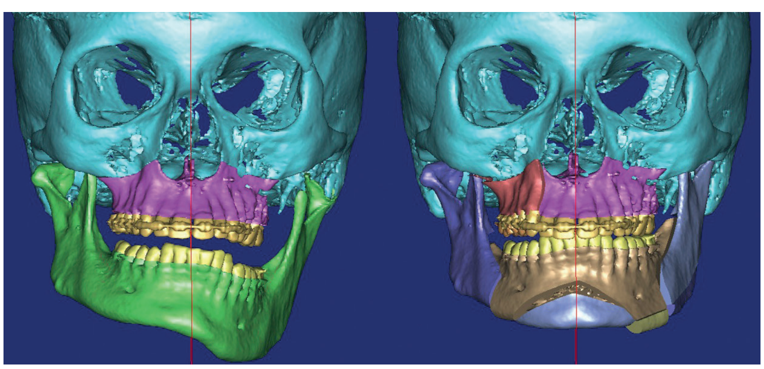


Figure 15: Three-dimensional simulation of the surgical plan. The magnitude of anticipated lower border resection was minimized to 5 mm.

doi:10.12889/2016_C00248

Figure 16: a) Immediate postoperative occlusion; b) orthodontic treatment restarted three months after surgery with 16/22 Niti upper arch and 014 Niti lower arch; c) management of the central line, sagittal discrepancy, and vertical control with 18/25 stainless steel upper arch and 18/25 Niti 240 grams lower arch; and d) bite settling elastics.

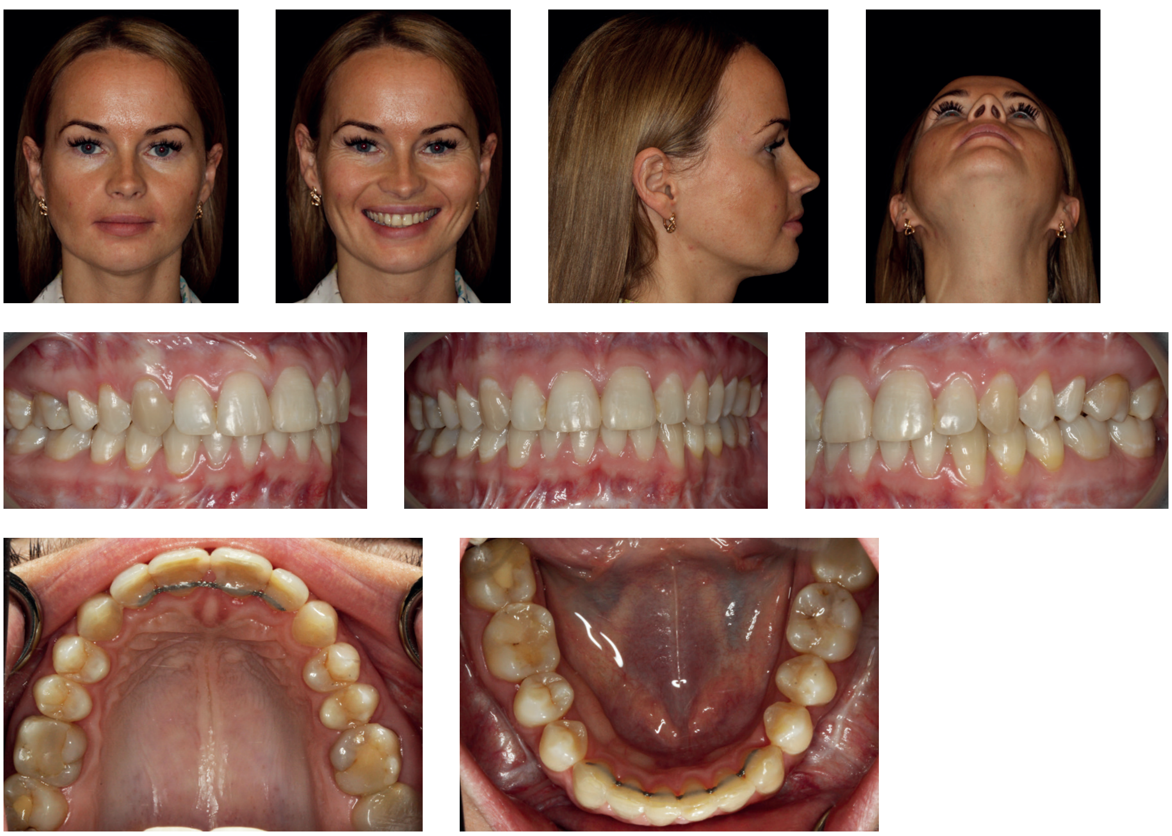


Figure 17: Final treatment outcome one year after surgery.

doi:10.12889/2016_C00248

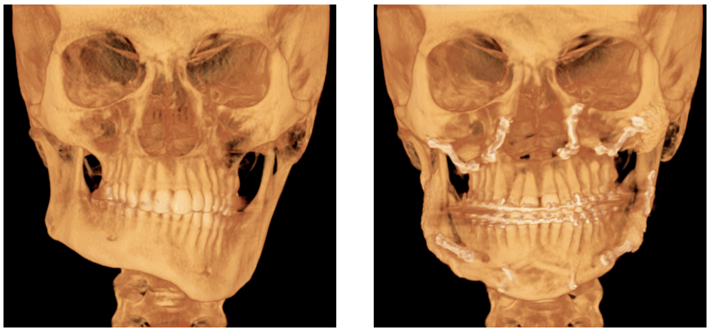


Figure 18: CBCT scans before treatment and ten months after surgery.

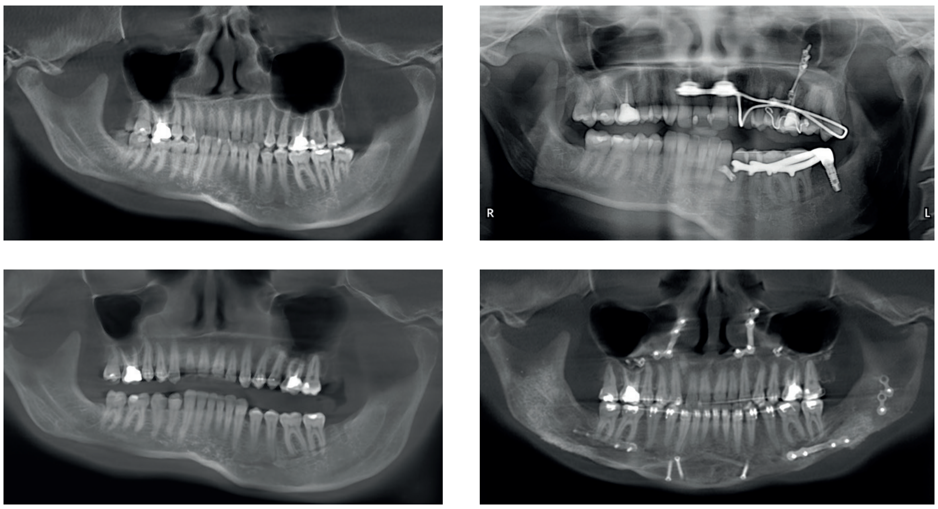


Figure 19: Ortopantomograms:
a) before molar intrusion;
b) during molar intrusion;
c) before orthognathic surgery;
d) ten months after orthognathic surgery.

REFERENCE LIST

1. Obwegeser HL. Condylar Hyperactivity, in *Mandibular Growth Anomalies*, 1st ed. Springer-Verlag Berlin Heidelberg 2001, pp. 139–144.
2. Obwegeser HL. Hemimandibular Hyperplasia (H.H.), in *Mandibular Growth Anomalies*, 1st ed. Springer-Verlag Berlin Heidelberg 2001, pp.145–150.
3. Takano-Yamamoto T, Kuroda S. Titanium screw anchorage for correction of canted occlusal plane in patients with facial asymmetry. *Am J Orthod Dentofacial Orthop* 2007;**132**:237–242.
4. Jeon YJ, Kim YH, Son WS, Hans MG. Correction of a canted occlusal plane with miniscrews in a patient with facial asymmetry. *Am J Orthod Dentofacial Orthop* 2006;**130**:244–252.
5. Ferguson JW. Definitive surgical correction of the deformity resulting from hemimandibular hyperplasia. *J Craniomaxillofac Surg* 2005;**33**:150–157.
6. Pelo S, Correra P, Gasparini G, Marianetti TM, Cervelli D, Grippaudo C, et al. Three-dimensional analysis and treatment planning of hemimandibular hyperplasia. *J Craniofac Surg* 2011;**22**:2227–2234.
7. Rahpeyma A, Khajehahmadi S. Inferior alveolar nerve repositioning and orthognathic surgery. *J Craniofac Surg* 2014;**25**:435–438.
8. Han G, Huang S, Von den Hoff JW, Zeng X, Kuijpers-Jagtman AM. Root Resorption after Orthodontic Intrusion and Extrusion: An Intraindividual Study. *Angle Orthod* 2005;**75**:912–918.
9. Xu T, Baumrind S. The relationship between apical root resorption and orthodontic tooth movement in growing subjects. *Chin J Stomat* 2002;**37**:265–268.
10. Baumrind S, Korn EL, Boyd RL. Apical root resorption in orthodontically treated adults. *Am J Orthod Dentofacial Orthop* 1996;**110**:311–320.
11. Casa MA, Faltin RM, Faltin K, Sander F, Arana-Chavez VE. Root resorption in upper first premolars after application of continuous torque moment. Intra-individual study. *J Orofac Orthop* 2001;**62**:285–295.
12. Faltin RM, Arana-Chavez VE, Faltin K, Sander FG, Wichelhaus A. Root resorptions in upper first premolars after application of continuous intrusive forces. Intra-individual study. *J Orofac Orthop* 1998;**59**:208–219.
13. Cornelis MA, Scheffler NR, Mahy P, Siciliano S, De Clerck HJ, Tulloch JF. Modified miniplates for temporary skeletal anchorage in orthodontics: placement and removal surgeries. *J Oral Maxillofac Surg* 2008;**66**:1439–1445.
14. Eline EB, De Clerck H; Swennen GR. Success rate of miniplate anchorage for bone anchored maxillary protraction. *Angle Orthod* 2011;**81**:1010–1013.
15. Jenner JD, Fitzpatrick BN. Skeletal anchorage utilising bone plates. *Aust Orthod J* 1985;**9**:231.
16. De Clerck H, Geerinckx V, Siciliano S. The Zygoma Anchorage System. *J Clin Orthod* 2002;**36**:455.
17. De Clerck H, Cornelis MA. Biomechanics of skeletal anchorage. Part 2: Class II nonextraction treatment. *J Clin Orthod* 2006;**40**:290.
18. Karagkiolidou A, Ludwig B, Pazera P, Gkantidis N, Pandis N, Katsaros C. Survival of palatal miniscrews used for orthodontic appliance anchorage: a retrospective cohort study. *Am J Orthod Dentofacial Orthop*. 2013;**143**:767–772.
19. Cornelis MA, Scheffler NR, Mahy P, Siciliano S, De Clerck HJ, Tulloch JF. Modified miniplates for temporary skeletal anchorage in orthodontics: placement and removal surgeries. *J Oral Maxillofac Surg* 2008;**66**:1439-45.

doi:10.12889/2016_C00248

clinical TIPS

A Simple Method for Transferring Bonded Appliances

Ayman El Nigoumi
Department of Orthodontics and Dentofacial Orthopedics, Cairo University, Cairo, Egypt

Correspondence:
e-mail: aymanelnigoumi@gmail.com

Article history:
Received: 05/03/2016
Accepted: 29/03/2016
Published online: 01/06/2016

Conflict of interest:
The author declares that he has no conflicts of interest related to this research.

How to cite this article:
El Nigoumi A. A simple method for transferring bonded appliances. *EJCO* 2016;**4**:49-52.

Abstract

Bonding appliances on palatal/lingual surfaces of teeth such as transpalatal arch (TPA), chromosome, Nance button, intrusive and distalizing appliances are becoming more common as bonding agents have become more reliable. Appliance bonding saves time, visits and cost compared to the installation of traditional appliances soldered on bands. The time required for band fitting, impressions, pouring in stone, fabrication of appliance, soldering and appliance cementation is replaced by just taking an impression or duplicating the study model of the patient, fabricating the appliance then bonding it intraorally. In addition bands have major drawbacks such as periodontal breakdown and residual spaces after debonding.

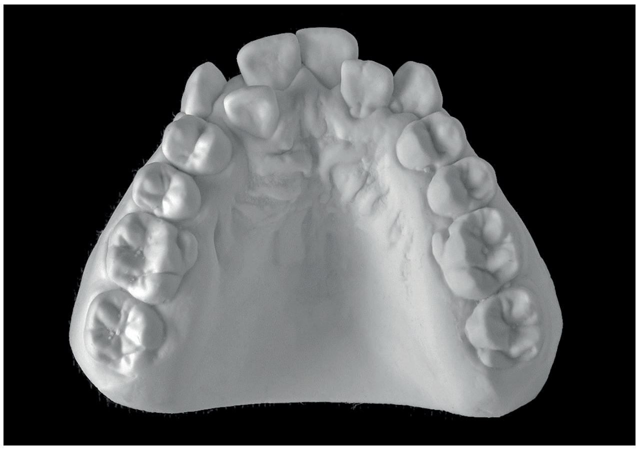
Bonding of palatal appliances is a technique-sensitive procedure. Two challenges are always present during appliance bonding: moisture control on multiple etched surfaces and difficulty stabilizing the appliance in the small intra-oral environment until bonding of all resting arms is complete. Precision is very important to ensure that the appliance was transferred accurately and the bond strength is not jeopardized.

The purpose of this article is to introduce a simple way to transfer palatal appliances using a wax gun technique. This technique is utilized in the indirect bonding technique to transfer brackets and bondable tubes. The advantages of indirect transfer of palatal appliances using this simple technique include ease of handling the appliance intraorally with a single digital pressure, precise transfer, low cost and time saving.

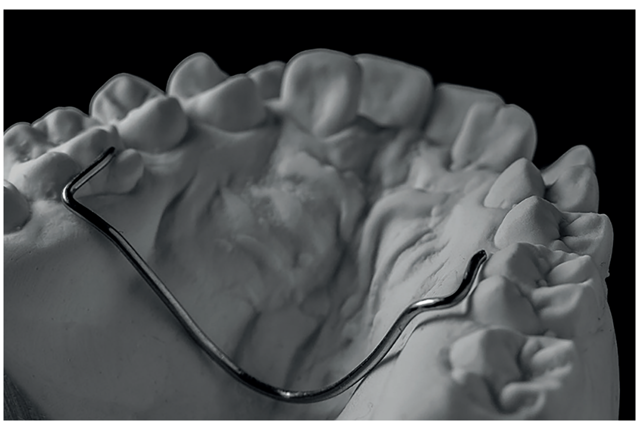
Keywords
Transpalatal appliances, TPA, bonding

doi:10.12889/2016_T00249

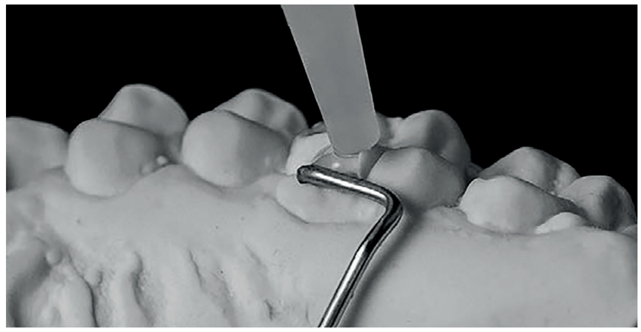
1 Duplication of the patient's study model.



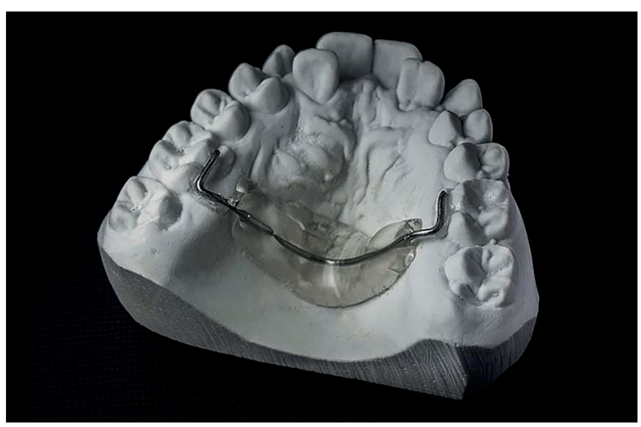
2 Fabrication of a TPA using 0.040" Stainless Steel wire.



3 Addition of cyanoacrylate to temporarily stabilize the resting arms on molars.

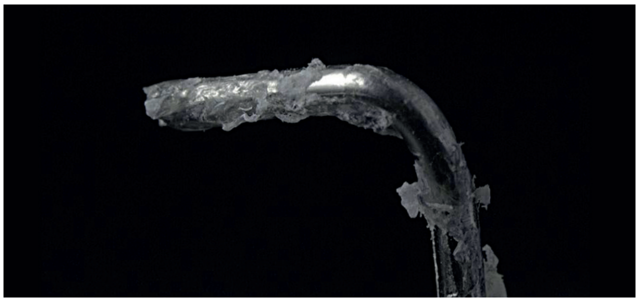


4 Gentle injection of molten wax from the heated gun on the entire wire length and around the TPA, followed by cooling down.

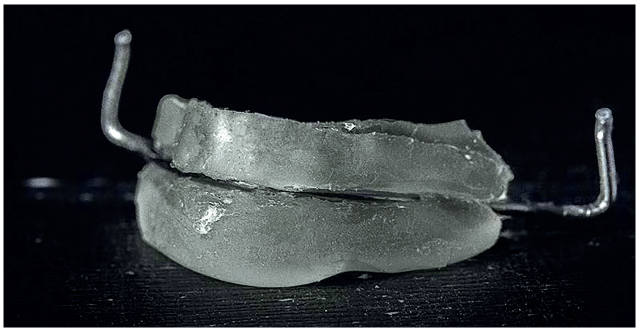


doi:10.12889/2016_T00249

5 Disassembly of the appliance. Resting arms will typically include residual stone and adhesive.



6 Incision of the wax on the tissue surface with a sharp knife to facilitate the removal of the appliance after bonding.

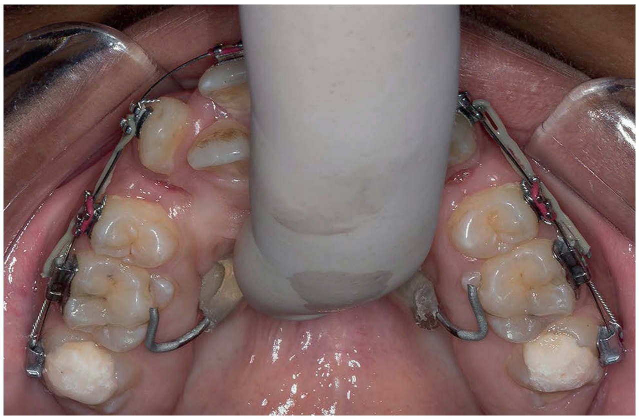


7 Sandblasting of both arms to remove residual glue and stone and create a rough surface to improve bonding to tooth surface.

8 Pumicing then etching of the palatal surface of first molars for 30 seconds. Rinsing and drying until chalky white appearance is observed and a layer of bond is added to the etched surfaces, followed by air thinning.

doi:10.12889/2016_T00249

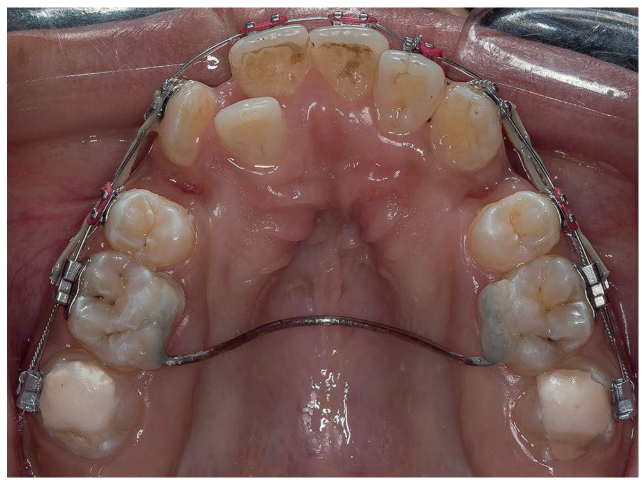
9 Application of digital pressure over the appliance using a single finger. The appliance rests precisely over the palatal surfaces of first molars.



10 Packing of composite with the other hand over the sandblasted arm and over the palatal surface, followed by light curing.

11 Removal of the wax tray around the TPA using a sharp probe.

12 A final photograph showing the bonded appliance transferred precisely in the designated position.

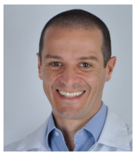


doi:10.12889/2016_T00249

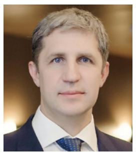
A "Forced Symmetry": Surgical Planning Protocol for the Treatment of Posterior Facial Asymmetries

Simonas Grybauskas
Maxillofacial Surgeon in Private Practice of Vilnius, Lithuania

Carlos Saiki
Maxillofacial Surgeon in Private Practice of Sao Paulo, Brazil



Octavio Cintra
Maxillofacial Surgeon in Private Practice of Sao Paulo, Brazil



Dainius Razukevičius
Maxillofacial Surgeon in Private Practice of Vilnius, Lithuania

Correspondence:
e-mail: drcarlos@cirurgiabucal.com

Article history:
Received: 01/03/2016
Accepted: 07/04/2016
Published online: 07/06/2016

Conflict of interest:
The authors declare that they have no conflicts of interest related to this research.

How to cite this article:
Grybauskas S, Saiki C, Cintra O, Razukevicius D. A "forced symmetry": surgical planning protocol for the treatment of posterior facial asymmetries *EJCO* 2016;**4**:53-59.

Abstract

Dentofacial deformities are usually treated surgically and virtual hard tissue simulation has been advised for increasing the accuracy of hard tissue repositioning. However, asymmetric patients in addition to different lateral projections of hard tissues (i.e. gonial angles or parasymphyseal areas) may also exhibit a noticeable difference in surrounding soft tissue thickness that may be underdiagnosed. Consequently, symmetrical positioning of the hard tissue framework will not guarantee postoperative soft tissue symmetry. In this paper we introduce a new surgical planning protocol called "forced symmetry" that allows us to predict final soft tissue symmetry by mimicking facial symmetry using clinical rotation of the mandible in unoperated patients. Double cone-beam CT scanning allows surface-based superimposition of virtual head models in centric relation and in forced relation. The resultant composite head model reveals the target lateral projection of proximal fragments that guarantees the best soft tissue symmetry in the gonial areas.

Keywords
facial asymmetry, orthognathic surgery, three-dimensional virtual planning, gonial angle

doi:10.12889/2016_C00251

BACKGROUND

Studies usually only take the chin and nose areas into consideration for the measurement and correction of facial asymmetry[1,2]. *Zhanga et al.*[3] observed that a deviation of 2 mm or more from the facial midline makes females less attractive than their peers.

Facial imbalance due to mandibular asymmetry is difficult to plan when there is a difference in lateral projection of hard tissues, e.g., gonial angles. A difference in the lateral projection of the gonial angles may be obvious and perceived as asymmetry and was observed to be quite noticeable in asymmetric patients[4].

Hard tissue three-dimensional (3D) virtual treatment planning is common in contemporary orthognathic surgery, mainly due to its accuracy compared to two-dimensional (2D) cephalometric measurement[5,6]. In some asymmetric patients, hard tissue 3D simulation and virtual centering to the midsagittal plane may be insufficient if soft tissue thickness on both sides varies. *Gao et al.*[7] reported that the main difference in asymmetric patients is located at the level of the bone, with soft tissue thickness being more symmetrical than the bone. Consequently, hard tissue repositioning around the face midline should be followed by good soft tissue adaptation. However, if soft tissue thickness is not equal bilaterally, a residual soft tissue asymmetry may be noticed. *Kwon et al.*[8] determined the bilateral difference in muscle volume in asymmetric patients with mandibular prognathism compared to symmetric patients. Data on soft tissue thickness changes in gonial areas after orthognathic surgery are sparse, although according to *Lee*[1], soft tissue thickness does not change during long-term follow-up.

Figure 1: A 21-year-old female patient with Class III occlusion and hemimandibular elongation in: (a) centric relation with wax-bite registration, and (b) a forced symmetry position (note correction of posterior facial asymmetry).

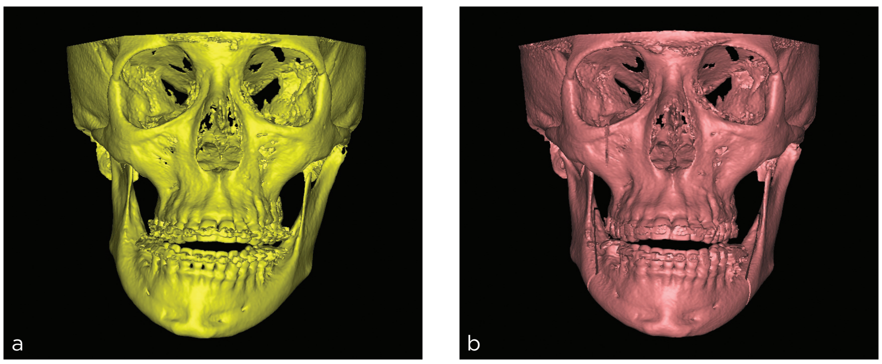


Figure 2: Virtual skull model: (a) centric relation, (b) forced symmetry position.

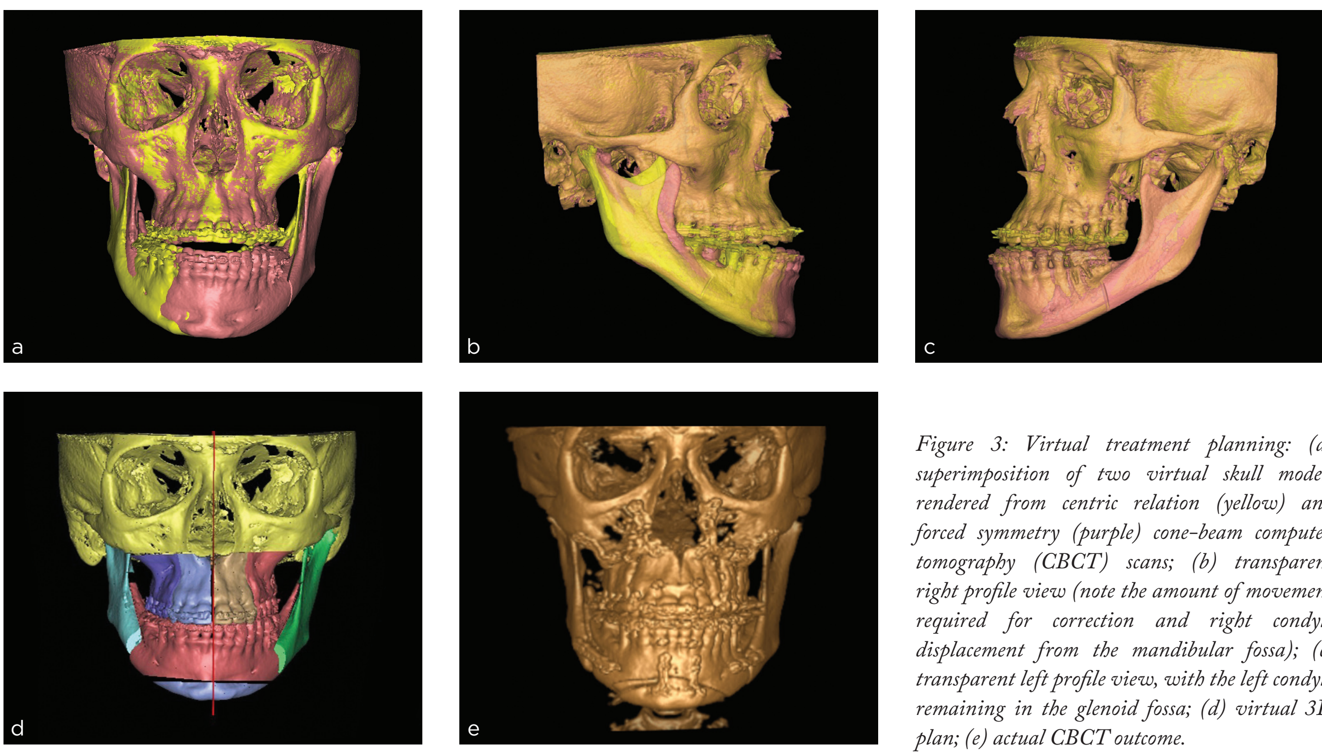


Figure 3: Virtual treatment planning: (a) superimposition of two virtual skull models rendered from centric relation (yellow) and forced symmetry (purple) cone-beam computed tomography (CBCT) scans; (b) transparent right profile view (note the amount of movement required for correction and right condyle displacement from the mandibular fossa); (c) transparent left profile view, with the left condyle remaining in the glenoid fossa; (d) virtual 3D plan; (e) actual CBCT outcome.

doi:10.12889/2016_C00251

Figure 4: Surgery outcome: (a,b) facial front photographs before and 4 years after surgery; (c,d) occlusal photographs before and 4 years after surgery.

If a noticeable residual asymmetry at the gonial angles remains after orthognathic surgery, additional interventions may be required to enhance the weaker side[9] or reduce the stronger side[10,11] through either surgical[12-14] or non-surgical[15-19] methods.

Soft tissue asymmetry can be corrected either by non-surgical or surgical modification of soft tissue thickness, or by positioning the hard tissue without altering the soft tissue using 'reverse soft tissue treatment planning'.

METHODS

The 'forced symmetry' protocol

Planning the correction of facial asymmetry can be simplified by clinical simulation to minimize or correct posterior facial asymmetry. The mandible is rotated in the axial plane and a new starting point for the planning procedure is established. The patient is asked to rotate their jaw in order to move the chin to the facial midline and make the soft tissue gonial angle areas appear as symmetrical as possible. It does not matter if the chin deviation is corrected, undercorrected or overcorrected, as the objective of this simulation is the correction of soft tissue symmetry in the posterior face. The non-centric forced symmetry (FS) position is recorded and serves as a starting point for the entire planning procedure.

Indications:

- Any posterior asymmetry in gonial angle areas that can be simulated into symmetry through rotation of the mandible in the axial plane.

Contraindications:

- Small posterior asymmetries, in which small transverse changes are needed, allowing clinical decisions to be made with high accuracy.
- Anterior facial asymmetries without asymmetry in the posterior area, when any rotation of the mandible in the axial plane to correct the anterior asymmetry results in worsening of the posterior asymmetry.

Workflow:

1. The patient is positioned in an upright position in front of the examiner. Gradual rotation of the lower jaw in the axial plane is actively performed by the patient until the soft tissue in gonial angle areas acquires the most symmetric position. The interrelationship of the dental midlines is noted and will later be reproduced during the bite registration procedure.
2. The patient is positioned in the supine position. Two bite registers are created. First, bite registration in centric relation (CR) with first tooth contact is performed *(Fig. 1a)* using bimanual manipulation of the mandible as advocated by *Dawson*[20].
3. Second, an FS position is reproduced by rotating the relaxed mandible passively until the lower dental arch achieves an interrelation with the upper dental arch recorded in step 1. A new registration wax-bite is used to register this position *(Fig. 1b)*.
4. Two cone-beam computed tomography (CBCT) scans are performed (I-Cat Next Generation; Imaging Sciences International, Hatfield, USA). The first scan is a high definition scan that is routinely performed for all patients before orthognathic surgery with CR wax-bite registration (16 × 22 cm scan, voxel size 0.3 mm, tube voltage 120 kVp, tube current 5 mA). This scan must include the entire maxillofacial area from the glabella to the hyoid bone and from the nasal tip to the middle cranial base. The second scan is a low radiation exposure scan with FS wax-bite registration (13-22 cm scan, voxel size 0.3-0.4 mm, tube voltage 120 kVp, tub current 5 mA). This scan must include the upper and lower jaws, and preferably the zygomatic arches and zygomatic bones - anatomical structures that do not change position are at a distance from each other and from the mandible and may be used for superimposition of the two scans. A low dose scan is performed because all that is needed from this scan is information on the macro-anatomy and the transverse position of the lower jaw in forced relation. Virtual head models are created for both CBCT scans using Simplant Pro software (Version 14.0; Materialise Dental, Leuven, Belgium) or any other 3D planning software. In the CR head model, posterior facial asymmetry and well-seated condyles can be observed, whereas in the FS head model, the posterior facial asymmetry has been compensated for by jaw rotation, but one of the condyles has been displaced from the glenoid fossa because the mandible has been rotated.
5. Upper and lower model casts are scanned separately as are the CR and FS wax bites (3Shape D700; 3Shape, Copenhagen, Denmark). Two pairs of STL files are exported from the optical scanner

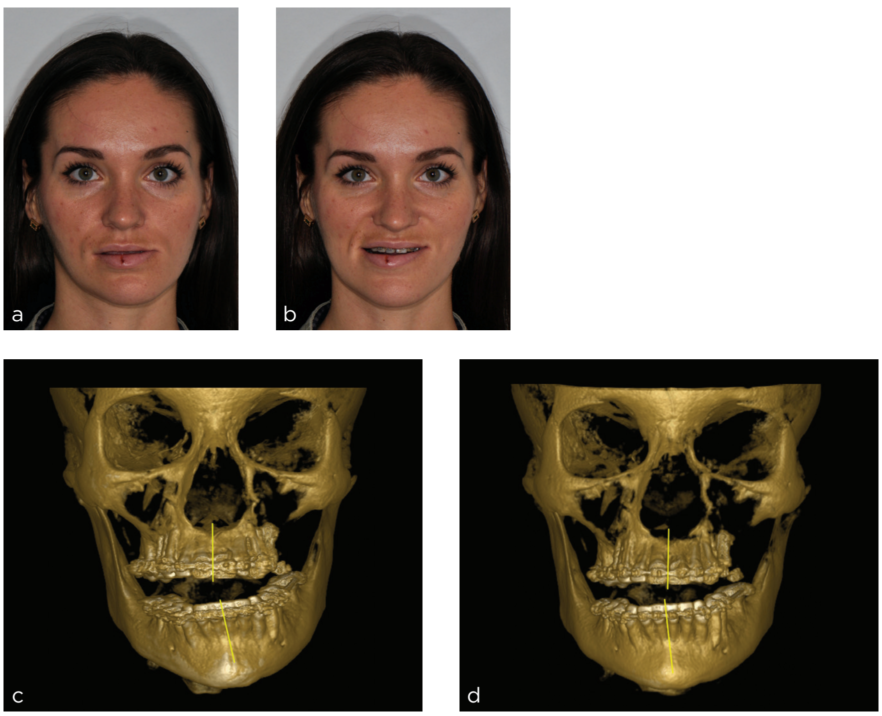
doi:10.12889/2016_C00251

software (OrthoAnalyzer; 3Shape, Copenhagen, Denmark).

6. Models scanned in FS are imported into Simplant software and superimposed on the virtual head model in FS. Models scanned in CR are imported into Simplant software and superimposed on the virtual head model in CR. CBCT teeth are replaced with scanned teeth in both files *(Fig. 2a,b)*.
7. FS and CR virtual head models are superimposed on the skull and upper teeth m*(Fig. 3a-c)*. This is achieved by loading 3D objects from the forced relation head model into the CR head model in the software. It must be emphasized that one of the condyles is displaced from the glenoid fossa in the forced relation CBCT scan. This displacement is associated with the jaw registration process in the symmetric position only and in the virtual planning process, but does not occur at surgery. When surgery is initiated on the lower jaw first, the mandible is split on both sides, and the teeth-bearing (distal) segment is put into an intermediate splint and wired to the upper dentition, while both condyle-bearing (proximal) segments are seated in the glenoid fossae and plated to the teeth-bearing fragment.
8. The position of the gonial angles on the FS virtual head model is used as a template for transverse positioning of the proximal fragments on the CR virtual head model. The position of the teeth-bearing segment is defined by a CAD/CAM intermediate splint that is rendered between the initial position of the upper teeth and the repositioned lower teeth. During surgery, the positions of proximal segments are reproduced free hand from the 3D virtual plan based on the exact relationship of the distal and proximal segments and contact points or gaps that must be maintained between the segments. However, there is often not much freedom at this point since the transverse positions of the proximal segments are controlled by the transverse position of the distal segment that is in turn determined by the CAD/CAM splint.

RESULTS

Figs. 1-6 demonstrate the workflow of the 'forced symmetry' planning technique that has been used for more than 50 patients in our practices. The post-treatment radiological data and clinical photographs can be used to assess the results obtained with this technique.



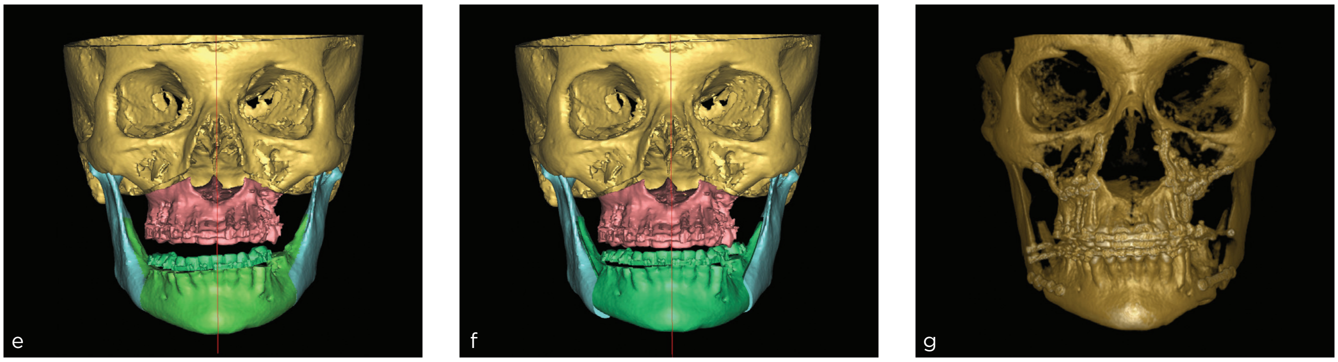


Figure 5: A 27-year-old female patient with Class III occlusion, partial adentia and hemimandibular elongation: (a,b) facial front view of the patient in centric relation and forced symmetry positions (note the improved facial symmetry at gonial areas in the forced symmetry position); (c,d) cone-beam computed tomography (CBCT) scans performed in centric relation and forced symmetry positions; (e) virtual planning: the mandible in the forced symmetry position allows osteotomy to be planned; (f) distal fragment moved to the planned position and proximal fragments maintained in the forced symmetry position; (g) CBCT scan after surgery.

doi:10.12889/2016_C00251

DISCUSSION

Orthognathic surgery can considerably improve facial asymmetry but further technique refinement is still required[21]. 3D virtual planning provides valuable information that helps errors common during face-bow transfer to be avoided or an intermediate splint in the articulator to be constructed[22].

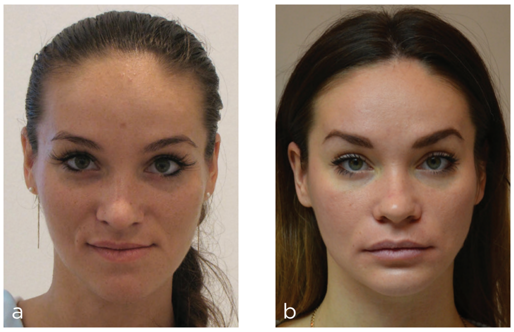
A recent study on the perception of facial asymmetries concluded that orthodontists, maxillofacial surgeons and laypersons are able to notice a 2 mm side deviation at the tip of the nose and a 4 mm side deviation at the chin level in a frontal view[23]. However, chin and gonial angle differences are the most significant factors affecting assessment of facial asymmetry[24]. The masticatory muscles play an important role in facial asymmetry as they may present differences in thickness when both sides are compared. *Kwon et al.*[8] showed that asymmetric patients have a wider gonial angle and greater hemimandibular volume on the longer side with less pterygoid muscle volume, reflecting differences in the spatial anatomy of a skeletal structure. *Goto et al.*[25] reported that patients with mandibular laterognathism have a smaller ipsilateral masseter muscle as compared to a control group, suggesting that latero-deviation initiates an adaptive process in the entire jaw system, resulting in extensive atrophy of the jaw muscles.

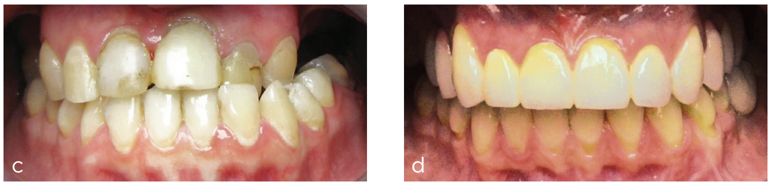
Data on soft tissue thickness changes in gonial areas after orthognathic surgery in asymmetric patients are sparse. Many studies on asymmetric patients do not include soft tissue alteration at the gonial angle, and only consider soft tissue around the nose, chin[1,2,26], lip and incisor teeth. A study by *Hagënsli et al.*[27] found that treatment results were positively ranked by more than 50% of patients even if asymmetry had not been completely corrected. This finding is controversial, although *Vasconcelos et al.*[28] stated that the patient's perception of their condition must be taken into account. Soft tissue changes after surgery are not always as expected[29]. *Lee* and *Yu*[30] investigated the masseter muscles of Class III asymmetric patients after orthognathic surgery and reported that muscle measurements showed no significant differences compared with a control group during a 4-year follow-up period. This suggests that soft tissue thickness does not adjust when the hard tissue framework is centered. Consequently, hard tissue symmetry may not always guarantee soft tissue symmetry if soft tissue thickness is different between the two sides of the face.

Differences were observed in the responses of thick and thin soft tissue at the midline (lips, nose and chin) after bimaxillary procedures[31], while soft tissue was reported to respond favorably to hard tissue correction in asymmetric patients[1]. *Gao et al.*[7] stated that simultaneous surgery to correct soft tissue and bone should be avoided as soft tissue is more symmetrical bilaterally than bone (i.e. bone is more asymmetrical than soft tissue). Similarly, *Yañez-Visco et al.*[32] concluded that the angulation of the mandibular ramus in the frontal and lateral planes determines apparent facial asymmetry, but did not evaluate soft tissue at the mandibular angle so their findings are restricted to hard tissues as usual[33-35].

It should be noted that small rotations of the mandible in the axial plane if not controlled during surgery cause changes in projections of the gonial angles and can cause asymmetry. Subsequently, when properly controlled, restitution of the symmetry of gonial angle areas can return symmetry to the face[36].

The FS protocol facilitates reverse treatment planning, where soft tissues dictate the position of hard tissues. It requires two CBCT scans: one in CR and the other in FS. The FS scan in our study provided data on the transverse position of the bones that make soft tissue appear symmetrical; however, one of the condyles is displaced from the glenoid fossa due to the forced relation of the





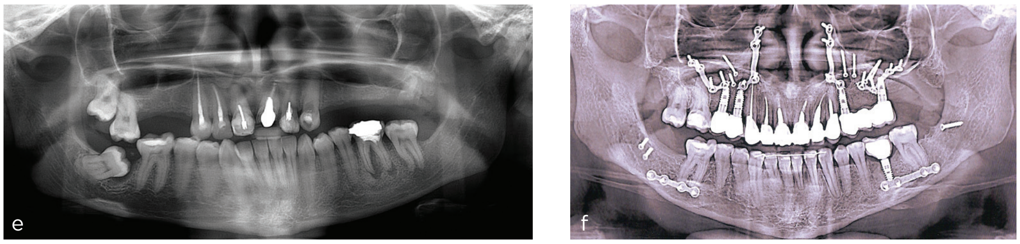


Figure 6: Surgical outcome: (a,b) facial front photographs before and 3 years after surgery; (c,d) occlusal photographs before and 3 years after surgery; (e,f) panoramic radiographs before and 1 year after treatment.

doi:10.12889/2016_C00251

mandible. Displaced condyles make a “maxilla-first” surgical approach impossible and so a “mandible-first” approach is mandatory if the main virtual planning is performed using a forced relation scan. A second CBCT scan in CR reveals the true position of the condyles in CR and facilitates both surgical protocols. Once superimposed on the cranial base and maxilla, the composite virtual head model provides all necessary information: the original condylar position (in the CR CT scan) and the desired transverse position of the proximal fragments (in the forced relation CT scan). The possibility of a perfect surgical outcome to an extensive surgical procedure justifies the double exposure. Although the effective CBCT dose must be considered and carefully controlled, it is important to remember that during a full skull scan CBCT effective doses range from 87 to 206 QSv as compared to multi-slice CT where they range from 474 to 1160 QSv[37,38]; in addition, the effective dose is continuously decreasing with the new generation of CBCT scanners. It is important to note that the forced relation scan can be performed in low dose mode and with a smaller volume since only the transverse position of gonial angles to be superimposed on the CR virtual head model is required. Our technique is based on clinical evaluation of the patient before surgical planning and on simplification of the planning process achieved by reducing facial asymmetry through clinical simulation of symmetry, thus allowing all surgical planning to be initiated from a new starting point. As far as we know, this is the first time that surgical planning based on a non-CR of the mandible has described in the literature.

Advantages:

- The forced symmetry protocol guarantees posterior facial symmetry provided symmetry can be successfully simulated by the patient through rotation of the lower jaw in to the middle of the face.

Disadvantages:

- Two cone-beam computed tomography scans are required for this protocol, however the risk-benefit ratio justifies the use of this protocol provided that the surgical procedure is planned and accurately performed from the very beginning.
- Planning using the forced symmetry protocol takes approximately 20% more time than regular virtual planning.

Future research:

- The behavior of asymmetric soft tissues in the gonial areas following orthognathic surgery has not be clarified.
- The forced symmetry planning protocol was developed under the assumption that the soft tissue thickness ratio between the sides remains the same after surgery.
- It is also not known if the technique could be limited to a single cone-beam computed tomography scan in forced symmetry relation while the centric relation (CR) position of the bones is reproduced from optical scans of dental models put into CR.
- The accuracy of the described technique should be validated.

CONCLUSIONS

The “forced symmetry” protocol may serve as a useful tool for planning the correction of posterior facial asymmetries. It can be used for patients with posterior asymmetries with different hard tissue projections and soft tissue thicknesses between the two sides of the face.

doi:10.12889/2016_C00251

REFERENCE LIST

1. Lee S, Mori Y, Minami K, An C, Park J, Kwon T. Does skeletal surgery for asymmetric mandibular prognathism influence the soft tissue contour and thickness? *J Oral Maxillofac Surg* 2013;**71**:1577–1587.
2. Hajeer MY, Ayoub AF, Millett DT. Three-dimensional assessment of facial soft-tissue asymmetry before and after orthognathic surgery. *Br J Oral Maxillofac Surg* 2004;**42**:396–404.
3. Zhanga Y, Xiaoa L, Lib J, Penga Y, Zhaoc Z. Young people's esthetic perception of dental midline deviation. *Angle Orthod* 2010;**80**:515–520.
4. Sforza C, Peretta R, Grandi G, Farronato G, Ferrario VF. Three-dimensional facial morphometry in skeletal Class III patients. A non-invasive study of soft-tissue changes before and after orthognathic surgery. *Br J Oral Maxillofac Surg* 2007;**45**:138–144.
5. Xia JJ, Shevchenko L, Gateno J, Teichgraeber JF, Taylor TD, Lasky RE, et al. Outcome study of computer-aided surgery simulation in the treatment of patients with craniomaxillofacial deformities. *J Oral Maxillofac Surg* 2011;**69**:2014–2024.
6. Gateno J, Xia JJ, Teichgraeber JF. Effect of facial asymmetry on 2-dimensional and 3-dimensional cephalometric measurements. *J Oral Maxillofac Surg* 2011;**69**:655–662.
7. Gao YM, Qiu WL, Shen GF, Tang YS. A preliminary cephalometric study on characters of facial soft tissue in mandibular asymmetry cases. *Shanghai Kou Qiang Yi Xue* 1999;**8**:141–142.
8. Kwon TG, Lee KH, Park HS, Ryoo HM, Kim HJ, Lee SH. Relationship between the masticatory muscles and mandibular skeleton in mandibular prognathism with and without asymmetry. *J Oral Maxillofac Surg* 2007;**65**:1538–1543.
9. Semergidis TG, Migliore SA, Sotereanos GC. Alloplastic augmentation of the mandibular angle. *J Oral Maxillofac Surg* 1996;**54**:1417–1423.
10. Yuan J, Zhu QQ, Zhang Y, Qi ZL, Wei M. Influence of partial masseter muscle resection along with reduction of mandibular angle. *J Craniofac Surg* 2013;**24**:1111–1113.
11. Min L, Lai G, Xin L. Changes in masseter muscle following curved ostectomy of the prominent mandibular angle: an initial study with real-time 3D ultrasonography. *J Oral Maxillofac Surg* 2008;**66**:2434–2443.
12. Deshpande S, Munoli A. Long-term results of high-density porous polyethylene implants in facial skeletal augmentation: an Indian perspective. *Indian J Plast Surg* 2010;**43**:34–39.
13. Stringer D, Brown B. Correction of mandibular asymmetry using angled titanium mesh. *J Oral Maxillofac Surg* 2009;**67**:1619–1627.
14. Gui L, Yu D, Zhang Z, Changsheng LV, Tang X, Zheng Z. Intraoral one-stage curved osteotomy for the prominent mandibular angle: a clinical study of 407 cases. *Aesthetic Plast Surg* 2005;**29**:552–557.
15. Van-Loghem J, Yutskovskaya YA, Werschler P. Calcium hydroxylapatite: over a decade of clinical experience. *J Clin Aesthet Dermatol* 2015;**8**:38–49.
16. Endara MR, Allred LJ, Han KD, Baker SB. Applications of fat grafting in facial aesthetic skeletal surgery. *Aesthet Surg J* 2014;**34**:363–373.
17. Cha YR, Kim YG, Kim JH, Kim ST. Effect of unilateral injection of botulinum toxin on lower facial asymmetry as evaluated using three-dimensional laser scanning. *Dermatol Surg* 2013;**39**:900–906.
18. Nácul AM. Contour of the lower third of the face using an intramuscularly injectable implant. *Aesthetic Plast Surg* 2005;**29**:222–229.
19. Sari A, Yavuzer R, Ayhan S, Tuncer S, Latifoğlu O, Atabay K, et al. Hard tissue augmentation of the mandibular region with hydroxyapatite granules. *J Craniofac Surg* 2003;**14**:919–923.
20. Dawson PE. Centric relation. Its effect on occluso-muscle harmony. *Dent Clin North Am* 1979;**23**:169–180.
21. Verzé L, Bianchi FA, Schellino E, Ramieri G. Soft tissue changes after orthodontic surgical correction of jaws asymmetry evaluated by three-dimensional surface laser scanner. *J Craniofac Surg* 2012;**23**:1448–1452.
22. Sharifi A, Jones R, Ayoub A, Moos K, Walker F, Khambay B, et al. How accurate is model planning for orthognathic surgery? *Int J Oral Maxillofac Surg* 2008;**37**:1089–1093.
23. Meyer-Marcotty P, Stellzig-Eisenhauer A, Bareis U, Hartmann J, Kochel J. Three-dimensional perception of facial symmetry. *Eur J Orthod* 2011;**33**:647–653.
24. Lee M, Chung DH, Lee J, Cha K. Assessing soft-tissue characteristics of facial asymmetry with photographs. *Am J Orthod Dentofacial Orthop* 2010;**138**:23–31.
25. Goto TK, Nishida S, Yahagi M, Langenbach GE, Nakamura Y, Tokumori K, et al. Size and orientation of masticatory muscles in patients with mandibular laterognathism. *J Dent Res* 2006;**85**:552–556.
26. Almeida RC, Cevidanes LHS, Carvaho FAR, Motta AT, Almeida MAO, Styner M, et al. Soft tissue response to mandibular advancement using 3D CBCT scanning. *Int J Oral Maxilofac Surg* 2011;**40**:353–359.
27. Hagënsli N, Stenvik A, Espeland L, Asymmetric mandibular prognathism: outcome, stability and patient satisfaction after BSSO surgery. A retrospective study. *J Craniomaxillofac Surg* 2014;**42**:1735–1741.
28. Vasconcelos BCE, Gonçalves F, Andrade A, Guillen M, Landim F. Mandibular asymmetry: literature review and case report. *Braz J Otorhinolaryngol* 2012;**78**:137.
29. Ferrario VF, Sforza C, Schmitz JH, Santoro F. Three-dimensional facial morphometric assessment of soft tissue changes after orthognathic surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1999;**88**:549–556.
30. Lee DH, Yu HS. Masseter muscle changes following orthognathic surgery: a long-term three-dimensional computed tomography follow-up. *Angle Orthod* 2012;**82**:792–798.
31. Abeltins A, Jakobsone G. Soft tissue thickness changes after correcting Class III malocclusion with bimaxillary surgery. *Stomatologija* 2011;**13**:87–91.
32. Yañez-Visco RM, Iglesias-Liñares A, Torres-Lagares D, Gutierres-Perez JL, Solano-Reina E. Three-dimensional evaluation of craniofacial asymmetry: an analysis using computed tomography. *Clin Oral Investig* 2011;**15**:729–736.
33. Yoo JY, Kwon YD, Suh JH, Ko SJ, Lee B, Lee JW, et al. Transverse stability of the proximal segments after bilateral sagittal split ramus osteotomy for mandibular setback surgery. *Int J Oral Maxillofac Surg* 2013;**42**:994–1000.
34. Hwang HS, Hwang CH, Lee KH, Kang BC. Maxillofacial 3-dimensional image analysis for the diagnosis of facial asymmetry. *Am J Orthod Dentofacial Orthop* 2006;**130**:779–785.
35. Katsumata A, Fujishita M, Maeda M, Ariji Y, Ariji E, Langlais RP. 3D-CT evaluation of facial asymmetry. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005;**99**:212–220.
36. Grybauskas S, Deryabin G. Adjusting the bone fragments, in Grybauskas S, Deryabin G. Bilateral sagittal split of the mandible in detail. Vilnius: iBrand, 2014, pp. 47–57.
37. Loubele M, Bogaerts R, Van Dijck E, Pauwels R, Vanheusden S, Suetens P, et al. Comparison between effective radiation dose of CBCT and MSCT scanners for dentomaxillofacial applications. *Eur J Radiol* 2009;**71**:461–468.
38. Silva MA, Wolf U, Heinickle F, Bumann A, Visser H, Hirsch E. Cone-beam computed tomography for routine orthodontic treatment planning: a radiation dose evaluation. *Am J Orthod Dentofacial Orthop* 2008;**133**:640.e1–5.

doi:10.12889/2016_C00251

clinical TIPS

New Bracket Positioner for Accurate and Precise Bracket Placement

Hemanth Madaiha
Deparment of Orthodontics and Dentofacial Orthopaedics, Dayananda Sagar College of Dental Sciences, Bangalore, India

Kabbur J Karthik
Deparment of Orthodontics and Dentofacial Orthopaedics, Dayananda Sagar College of Dental Sciences, Bangalore, India

Chaithra Doddabyregowda
Deparment of Orthodontics and Dentofacial Orthopaedics, Dayananda Sagar College of Dental Sciences, Bangalore, India

Correspondence:
e-mail: chaitra.raju.d@gmail.com

Article history:
Received: 22/03/2016
Accepted: 29/03/2016
Published online: 08/06/2016

Conflict of interest:
The authors declare that they have no conflicts of interest related to this research.

How to cite this article:
New bracket positioner for accurate and precise bracket placement. *EJCO* 2016;**4**:60-61.

Abstract

Bracket positioning is critical in obtaining optimal results in orthodontic treatment. Accurate bracket positioning is the corner stone of treatment, ensuring that the built-in features of the bracket system can be efficiently expressed, thus maximizing the benefits and helping to achieve an ideal occlusion.
The bracket positioner described here incorporates measuring gauges at the posterior end of the conventional bracket holder, enabling the device to accurately position the brackets and also minimizing the number of instruments required.

The features of the new accurate and precise bracket holding instrument are:

- bracket holding;
- bracket positioning;
- orientation to the long axis of the tooth;
- measuring gauge;
- flash removal, from the pointed tip of the vertical extension.

Keywords
Bracket holder, bracket positioning, modifications

INTRODUCTION

The preadjusted bracket system is currently the most widely used system for orthodontic therapy. The basic premise of the preadjusted system is that proper bracket position allows the teeth to be positioned with a straight wire into an occlusal contact with excellent mesial distal inclinations (tip) and excellent faciolingual inclination (torque)[1].
Andrews introduced the technique of placing the bracket's vertical tie wings parallel to the long axis of the clinical crown and then moving the bracket up or down until the middle of its slot base is at the same height as the midpoint of the clinical crown[1].
Thurow showed that two different vertical positions of a bracket on a tooth will cause two different bucco-lingual axial inclinations (torque)[2].
Meyer and *Nelson* showed that a vertical error of 3 mm in bracket placement on a premolar can result in 15 degree torque alteration and 0.04 mm alteration in the in/out adjustments[5]. In orthodontics, what affects the design of the orthodontic appliances and their use is the inclination of the labial or buccal surface of the tooth crown to the long axis of either the entire tooth or the occlusal surface of the crown.

doi:10.12889/2016_T00253

All modifications and improvements in orthodontic appliances depend on the ability of the clinician to accurately visualize and correctly place the bracket on the tooth.
Poorly positioned brackets result in poorly placed teeth and necessitate more arch wire adjustments. This can lead to an increased treatment time or poor occlusion[3]. Several studies[2,4,5] have demonstrated that preadjusted orthodontic appliances cannot get the right tooth position with a straight wire because of poor bracket placement.
The aim of this paper is to introduce a new, simple device which helps in accurate positioning of brackets, reducing chairside time by minimizing the number of armamentarium required, and is easier to sterilise.

FABRICATION

A conventional bracket holder is chosen. A L-shaped stainless plate with a horizontal and vertical extension is soldered to the non-working side of the bracket holder with a hydro solder *(Fig. 1)*.

Figure 1: L-shaped attachment with a horizontal and vertical extension.

The surface of the attached L-shaped plate is engraved with measurements varying from 2.5 to 5.5 mm at intervals of 0.5 mm, colour coded alternatively - yellow 3 mm, red 4 mm, green 5 mm. *(Fig 2)*.

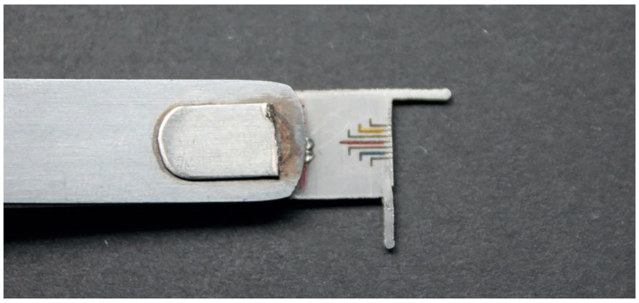


Figure 2: vertical measurements on horizontal arm, colour coded yellow-3mm, red-4mm, green-5mm

CLINICAL APPLICATION

Place this bracket holder on the labial/buccal surface of the teeth with the horizontal extension on the incisal/occlusal surface and the vertical extension parallel to the long axis of the tooth. Firmly press against the slot of the bracket, ensuring correct bracket placement in all 3 dimensions i.e, horizontal, vertical (height) and in/out adjustments. *(Figs. 3,4)*.

Figure 3: clinical demonstration (side view)

Figure 4: clinical demonstration (front view)

CONCLUSION

The advantages of this instrument are:
1. Minimum instruments
2. Time saving
3. Convenient
4. Convenient
5. Ease of access
6. Multifunctional
7. Easily sterilisable

REFERENCE LIST

1. Andrews LF. The six keys to normal occlusion. *Am J Orthod*. 1972; **62**:296–309.
2. Balut N, Klapper L, Sandrik J, Bowman D. Variations in bracket placement in the preadjusted orthodontic appliance. *Am J Orthod Dentofacial Orthop*. 1992; **102**:62–67.
3. Carlson SK, Johnson E. Bracket positioning and resets: five steps to align crowns and roots consistently. *Am J Orthod Dentofacial Orthop*. 2001; **119**:76–80.
4. Koo BC, Chung CH, Vanarsdall RL. Comparison of the accuracy of bracket placement between direct and indirect bonding techniques. *Am J Orthod Dentofacial Orthop*. 1999; **116**:346–351.
5. Miethke RR, Melsen B. Effect of variation in tooth morphology and bracket position on first and third order correction with preadjusted appliances. *Am J Orthod Dentofacial Orthop*. 1999; **116**:329–335.
6. A New Bracket-Positioning Gauge. *J Clin Orthodont*. 2001; **35**:154-155.

doi:10.12889/2016_T00253

Case-control Study: Analysis of Data and Bias

Bruno Oliva
Catholic University of Sacred Heart, Rome, Italy
Private Orthodontic Practice, Brindisi, Italy

How to cite this article:
Oliva B. Case-control study: Analysis of data and bias. *EJCO* 2016;**4**:62

In a previous article I described a case-control study[1] and reported an example of association between maxillary contraction and mouth breathing. The exposure to mouth breathing in cases (maxillary contraction) and controls (correct transverse diameter) has been identified and the hypothetical results are shown in *Table 1*.

The case-control study is retrospective so we can measure the odds of exposure based on disease and not the relative risk of disease[2].

The odds of exposure is the number of exposed subjects divided by the number of unexposed subjects.

In *Table 1*:

- the odds of exposure for cases is 70/20 = 3.5
- the odds of exposure for controls is 110/90 = 1.23

The odds ratio is the odds of exposure for cases divided by the odds of exposure for controls (3.5 / 1.23) = 2.86

To test if this result is not due to random error, a statistical test ($\chi2$) should be performed[3]. In our study $\chi2$ indicates that the odds ratio is statistically significant ($P<0.05$).

If odds ratio = 1 the exposure is not a risk factor.

If odds ratio >1 the exposure is a risk factor.

If odds ratio <1 the exposure reduces the risk of disease.

The odds ratio of our result indicates that mouth breathing is a risk factor for maxillary contraction.

However, this result could depend on other factors (confounders) or systematic errors (bias)[4].

Confounders are factors known or unknown that could influence the results. For example, a confounder in our study could be negative oral habits, such as thumb sucking or tongue thrusting. These could be risk factors for maxillary contraction and therefore they could complicate the analysis of the association between exposure and outcome.

The main types of bias in case-control studies are selection bias and information bias. The most important selection bias occurs in the selection of controls. They should be selected from the same population as the cases, but should not have the disease[4,5]. The most important information bias in case-control studies occurs when the recall of exposure is different between cases and controls. Experiencing or not experiencing the outcome can influence the recalling.

	Exposed (mouth breathers)	Unexposed (nose breathers)	**Total**
Cases (maxillary contraction)	70	20	90
Controls (correct transverse diameter)	110	90	200
Total	180	110	290

Table 1: Results of hypothetical case-control study.

REFERENCE LIST

1. Oliva B. Case-control study. *EJCO* 2016; **4**:31.
2. Levin KA. Study design V. Case-control studies. *Evid-Based Dent* 2003 **7**, 83-84.
3. Pandis N. Case-control studies: Part 1. *Am J Orthod Dentofacial Orthop.* 2014; **146**(2):266-267.
4. Oliva B. Introduction to Clinical Studies. *EJCO* 2014; **2**:63.
5. Pandis N. Bias in observational studies. *Am J Orthod Dentofacial Orthop.* 2014; **145**:542-543.

doi: 10.12889/2016_D00250