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The concept of bimaxillary transverse osteodistraction: a paradigm shift?

Abstract

Severe crowding due to narrow upper and lower apical bases can be corrected by the extraction of four premolars, or by bimaxillary transverse osteodistraction. The first strategy is prone to unaesthetic changes in lip posture, nasolabial angle and buccal corridors. Life-long retention is necessary because of the known correlation between increased intercanine distance and relapse of crowding. The second strategy involves surgery and the final outcome regarding stability is not yet known. Theoretically, because the canines have not been moved outside of the skeletal envelope, and because the functional matrix positively influences the dental arches, relapse of crowding should be less. Facial appearance is improved because of the reduction of the buccal corridors and the fullness of the mouth both at rest, and upon smiling.

Keywords

Osteogenesis · Distraction · Malocclusion · Orthodontics · Maxilla · Mandible

Society considers a person with an unattractive face to be less intelligent and less desirable [29]. No wonder that the majority of patients seeking orthodontic and ultimately orthognathic treatment do so because they perceive their dental and facial appearance as unattractive. Patients and their kin expect perfect and stable alignment of their teeth from the orthodontist, so that their smiles become pleasing for ever [23]. An important decision in the orthodontic treatment plan is whether to extract healthy teeth or not in order to achieve this goal. Extraction therapy is generally favoured when there is severe maxillary crowding and protrusion, severe mandibular crowding, protrusion and irregularity, and increased profile convexity. Arch perimeter increase by rapid palatal expansion, surgically assisted from late adolescence on, is a classic option for severe maxillary crowding [7]. It is especially indicated with a co-existing cross-bite. Until recently, there has been no analogue for the mandible.

Bimaxillary transverse osteodistraction is a new technique that allows an increase in both maxillary and mandibular arch perimeters simultaneously by increasing skeletal breadth. Guerrero [17] must be credited for popularizing symphyseal distraction and Weil et al. [47] for reporting the first series of bimaxillary transverse osteodistractions. This article aims to discuss the rationale for both extraction and distraction therapy, from an aesthetic viewpoint, in cases of severe maxillary and mandibular crowding, with or without a cross-bite.

Extraction therapy

Effect on facial appearance

Besides alignment, arch shape and occlusal plane, and individual tooth position, orthodontic extraction therapy will also have an influence on lip profile, the nasolabial angle, gingival display and buccal corridors.

Literature reports 2 mm or more recumbence of lips and incisors in four-premolar-extraction samples compared to non-extraction samples, in all types of Angle Classes, both post-treatment and post-retention [6, 10, 13, 36, 42]. This effect was also nicely demonstrated in 11.5-year-old twins with identical pretreatment dental, skeletal and soft tissue structures. Labrale superius was retruded 2.0 mm and labrale inferius 3.2 mm in the four-premolar-extraction case, 1 year after treatment [25]. Lip retrusion in extraction cases also leads to an increase in the nasolabial angle [6, 10, 13]. Concomitantly, total upper lip length increases and vermilion height decreases [10]. Midfacial ageing is related to maxillary retrusion [37] and a thin and long upper lip is a stigma of old age [1, 14].

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Das Konzept der bimaxillären transversalen Distraktionsosteogenese – Ein Paradigmawechsel?

Zusammenfassung

Erhebliche Engstände aufgrund einer zu schmalen Unter- bzw. Oberkieferbasis können entweder durch die Extraktion von vier Prämolaren oder durch die bimaxilläre transversale Distraktionsosteogenese korrigiert werden. Das erste Behandlungskonzept kann eine ästhetisch unvorteilhafte Veränderung der Lippenposition, des Nasolabialwinkels und der bukkalen Weichteilabstützung hervorrufen. Ferner ist eine lebenslange Retention aufgrund der bekannten Beziehung zwischen der vergrößerten Schneidezahnstufe und dem Engstandrezidiv notwendig. Das zweite Behandlungskonzept, dessen Langzeitergebnisse hinsichtlich der Stabilität noch unbekannt sind, bedingt eine Operation. Theoretisch erscheint ein Rezidiv des Engstands wenig wahrscheinlich, da die Schneidezähne im Bereich der skelettalen Basis verbleiben und da die funktionelle Integrität positiv gefördert wird. Die faziale Ästhetik wird durch den Erhalt der perioralen und bukkalen Weichteilabstützung sowohl in Ruhe als auch bei Lachen positiv beeinflusst.

Schlüsselwörter

Distraktionsosteogenese · Malokklusion · Kieferorthopädie · Maxilla · Mandibula

The "dishing-in" of the lower face after anterior maxillary segment set-back surgery, with extractions of the first premolars, results in adult patients complaining about an unattractive lip profile and premature ageing [45]. When premolars are extracted in the course of an orthodontic treatment, the patients are in general younger and still have sufficient lip pout. The change is therefore not dramatically acute and the retrusion of the upper front teeth less pronounced. Still, within the Angle Class II group, some patients seek surgical advice after orthodontic treatment with premolar extractions, because of these aforementioned effects (Fig. 1). In contrast, a comparative study on Class II malocclusion treated with and without premolar extractions, patients themselves showed no statistically significant tendency to prefer the aesthetic aspect of one strategy over the other [36]. Boley [5] found that general dentists and orthodontists could not, by looking alone, distinguish between treated extraction and non-extraction cases in any Angle Class. Indeed, unaesthetic results can be largely avoided by proper indication and technique. Extraction therapy should be considered only when the nasolabial angle is less than 110° and labrale superius and inferius are in good sagittal position [6, 13]. Substantial differences were noted between orthodontic offices and are related to the final position of the first molars. The upper front is retruded when the canines are moved distally instead of the first molars mesially [24].

Several authors have pointed out that detrimental increase in gingival display will frequently occur from orthodontic treatment with excessive use of intermaxillary elastics [23, 41]; such is the case with extractions.

Buccal corridors are defined as the dark shadows between the buccal surfaces of the dentition and the corners of the mouth. The buccal corridor ratio (maxillary canine width divided by the width of the mouth during smiling) is during smiling on average 0.6 (SD 0.04) in male, 0.57 (SD 0.04) in female persons [41]. It has been suggested that extraction of premolars leads to a narrowing of dental arch width and a decreased fullness of the dentition within the mouth during a smile. It is claimed that the buccal corridors become larger when arch width decreases, and that this is perceived as unaesthetic [12, 43].

Stability of alignment

The lower front teeth are aligned by extraction of mandibular premolars, or by increasing the intercanine distance orthodontically. There is a consensus that permanent retention is necessary, since all postretention reports document high rates of irregularity relapse with concomitant decrease in intercanine width. The longer the follow-up periods, the higher the relapse rate becomes [8, 22,

Fig. 1a–d ▼ **Seventeen-year-old girl with Class II malocclusion, after orthodontic compensation treatment with four premolar extractions.** a **Frontal view, lips closed.** b **Frontal view, smiling.** c **Profile view, lips closed. Note the obtuse nasolabial angle and the lip recumbence.** d **Profile view, smiling. Severe palatoversion of the upper front teeth**

28, 30, 36], with up to 90% relapsing more than 3.5 mm at 20 years [27]. This urged Little et al. [27] to state that extraction of healthy premolars is unacceptable for aligning mandibular front teeth.

A distinction should be made between orthodontic relapse and natural mesial drift [19] with continued decrease in mandibular arch length and arch width throughout life. The first type of resulting irregularity results from inadequate therapy, the second will also happen without therapy. Many interrelated factors may effect post-treatment mandibular crowding: mandibular growth in the broad sense, eruption of third molars, pre-treatment characteristics, treatment-related factors (including intercanine width, positioning of lower anterior teeth, and occlusal function), persistent habits, and retainer uses [22, 30].

A post-treatment decrease in intercanine width after an increase during treatment seems to correlate with an increase in the irregularity index [26, 30, 35]. There is a high risk for crowding when compensating orthodontic therapy has been performed to increase the intercanine width in the presence of primary transverse mandibular deficiency [47]. Orthodontic maxillary expansion in the presence of primary transverse maxillary deficiency also results in relapse, although less [2], but this has prompted Strang [44] to say that "the intercanine width remains inviolate". Also, without treatment the intercanine width remains fairly stable throughout life [4].

Distraction therapy

Arch perimeter increase

Premolar extractions are very effective in increasing space within a given arch perimeter. Space can also be gained by an increase in arch perimeter. Combined molar–canine expansion creates an increase in arch perimeter only slightly less than that generated by incisor advancement alone. A combination of both techniques, e.g. as in anterior transpalatal distraction [39], and in anterior transmandibular distraction [31], has the greatest impact [16].

Functional matrix

According to the functional matrix theory, any alterations in size, shape and growth of the skeletal unit is secondary to compensatory changes of its related functional matrix [34]. This is also true for the shape of the dentition. There is a correlation observed between maxillary and mandibular width increases, suggesting coordination between the jaws [15]. The post-retention position of the maxillary and mandibular canines is correlated [22]. Mandibular arch form dictates maxillary arch form. Thus, bimaxillary transverse osteodistraction will theoretically stabilize the newly formed arches.

Theoretically larger amounts of buccal or facial movement would result in a larger force, causing the expanded teeth to return toward their former position [48]. This may hold true for expansion at a dental level in the maxilla and mandible, and also for skeletal expansion in the maxilla only, but perhaps not for simultaneous bimaxillary skeletal expansion. With the latter procedure, the muscle insertions are displaced equally outward, and less pressure will result.

Tooth-borne or bone-borne distractors

Tooth-borne expanders have been used for more than half a century in surgically assisted rapid palatal expansion. Some of the physiological drawbacks, e.g. gingival recession, buccal root resorption and fenestration, are considered rare and cannot be addressed. The biomechanical disadvantages such as tipping of teeth and segments and consequent relapse (predominantly orthodontic; [40]), are known and minimized by over-expansion, reversed torque and prolonged retention.

Tooth-borne expanders have been used for only a decade in symphyseal osteodistraction [18]. The same adverse effects are noted as with tooth-borne maxillary expanders [3, 11]. Hollis et al. [24] noted that dog teeth moved approximately twice as much as the bone segments during distraction. This may cause problems, since expansion of alveolar bone when not supported by basal bone

Fig. 2a–d ▼ **Frontal views of a 15-year-old boy with dolichocephaly. (Orthodontist: Nicole Lammens, LDS, MSc).** a **Before bimaxillary transverse osteodistraction.** b **After the active distraction phase.** c **One year later, in the course of orthodontic treatment.** d **After debanding**

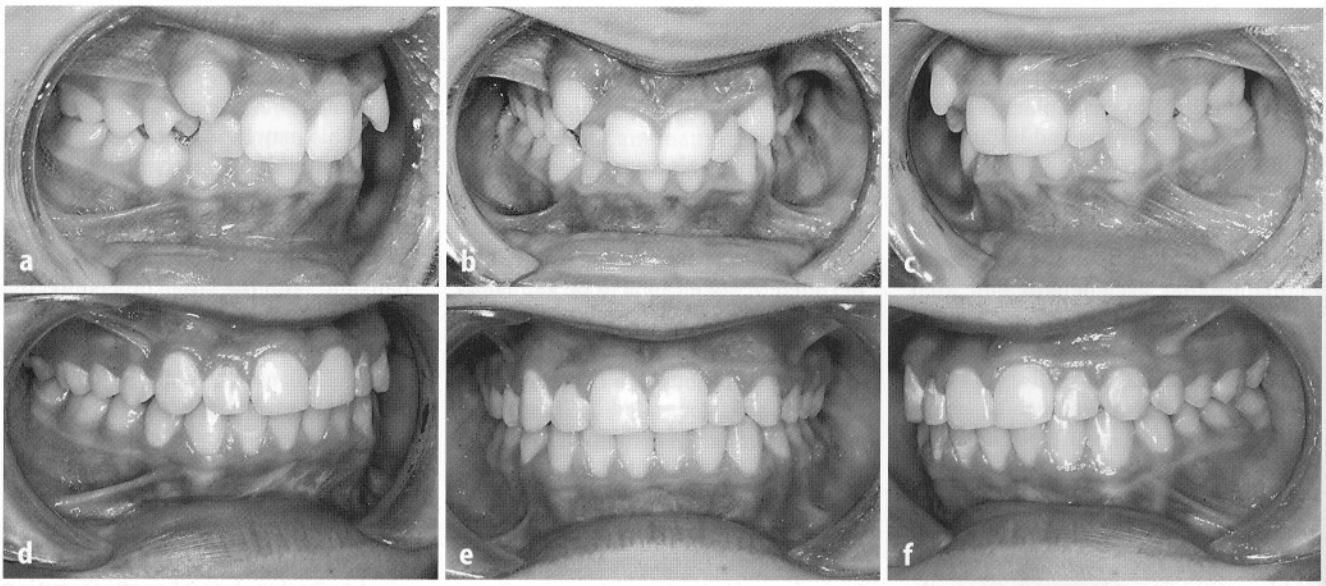

Fig. 3a–f ▲ **Views of the occlusion of a 15-year-old boy with dolichocephaly. (Orthodontist: Nicole Lammens, LDS, MSc).** a–c **Before treatment.** d–f **After bimaxillary transverse osteodistraction and orthodontic finishing**

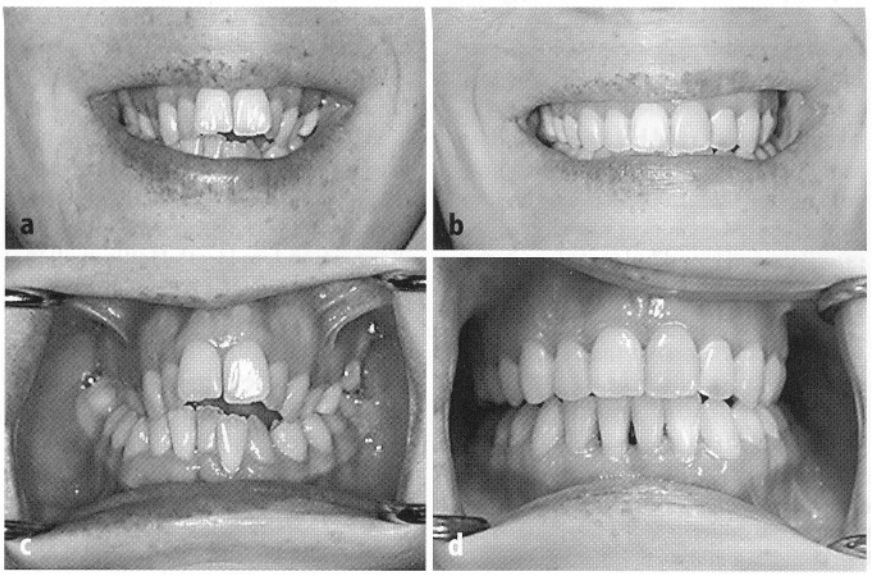

Fig. 4a–d ▲ **28-year-old female patient with severe malocclusion on a feline-like bimaxillary complex, treated by bimaxillary transverse osteodistraction and fixed orthodontics (Orthodontist: Ann Derijcke, LDS).** a, b **Pre-treatment frontal view of the occlusion. Buccal corridor ratio: 0.48.** c,d **Post-treatment frontal view, occlusion. After osteodistraction. Buccal corridor ratio: 0.63**

al occasions we have noted that anterior transpalatal distraction (without concomitant transmandibular distraction) will advance the incisors such that end-to-end incisor occlusion was easily corrected. However, we think that in most cases the effect will be lost during orthodontic alignment.

Smile aesthetics and stability of alignment

The advantages of surgically assisted rapid maxillary expansion over segmental osteotomies include unrivaled anterior expansion and good stability [38].

The stability of transpalatal and transmandibular distraction is not yet known. Our clinical impression over the last 4 years is favourable, but an experimental or clinical implant study should clarify this issue. It remains to be proven that the long-term outcome will be better than with four-premolar-extractions. Cousley and Jones [9] argue that the patients of Little et al. [27, 28] were treated during the 1960s when orthodontic management was limited compared to cur-

In the first reported series of simultaneous bimaxillary transverse osteodistraction, Weil et al. [47] reported [...] installed before [11].

A bone-borne device, producing anterior transverse distraction while avoid-

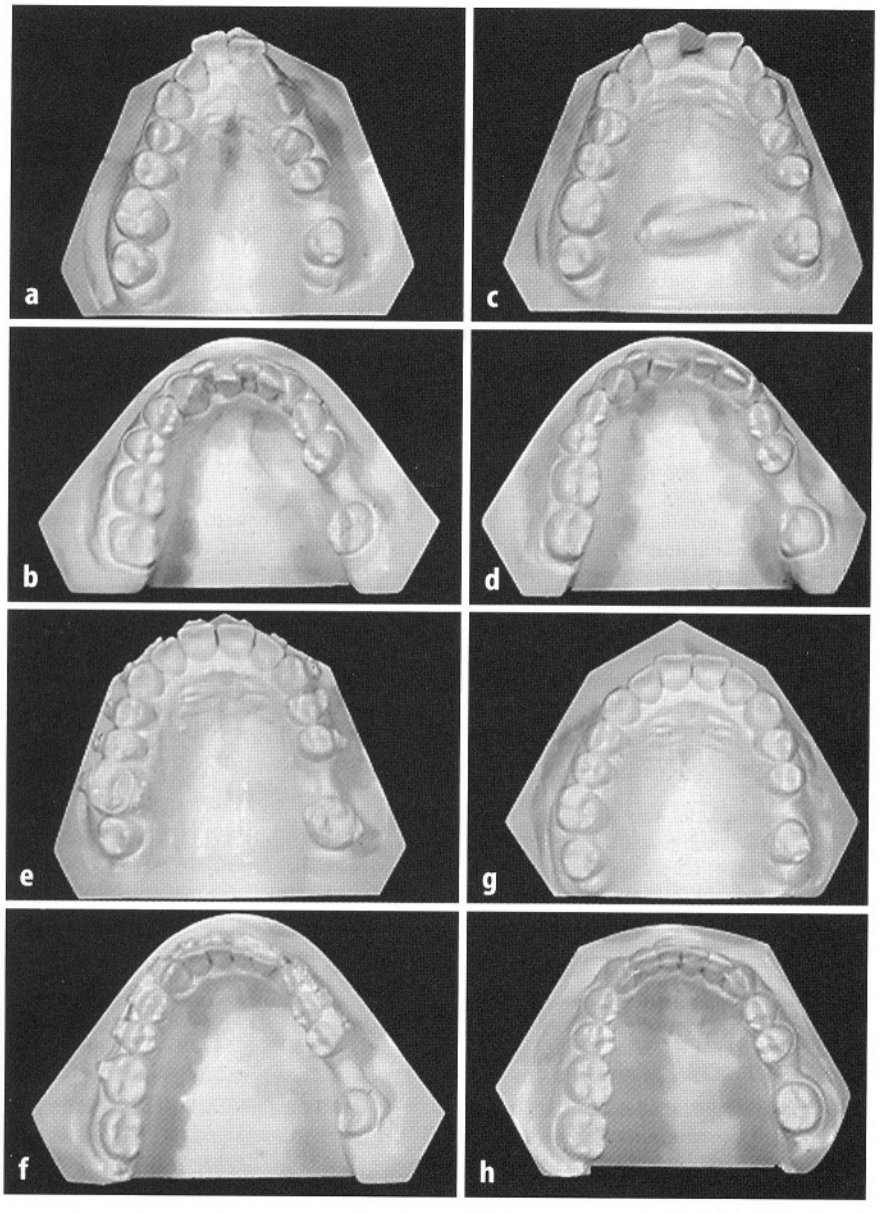

Fig. 5a–h ▲ **Models of the case of Fig. 4 (Orthodontist: Ann Derijcke, LDS).** a, b **Upper and lower jaw model before treatment.** c, d **Upper and lower jaw model after the active phase of osteodistraction. Note the TPD device on the palate. The TMD device was not included in the impression.** e, f **Upper and lower jaw model during orthodontic alignment.** g, h **Upper and lower jaw model after debanding**

lower face corrected the transverse facial proportions, decreased the buccal corridor ratio, allowed for alignment without extractions, and positioning of the dentition within the skeletal envelope (Fig. 2, Fig. 2, Fig. 3, Fig. 4, Fig. 5).

Description of bimaxillary transverse osteodistraction cases

Since this is a concept paper, the authors do not wish to analyse the patient material, but a description of the cases undergoing bimaxillary transverse osteodictraction is appropriate to demonstrate the feasibility of the technique. A case report has already been published [33]. Between June 1999 and September 2003, 24 patients (18 females) underwent simultaneous TPD and TMD as day case surgery. Their mean age was 20 years, 7 months. Twenty-six third molars were removed in the same surgical session. All patients received fixed orthodontic appliances and five of them underwent a second orthognathic surgical procedure, on average 17 months (min, 12; max, 23) after the TPD-TMD surgery. The second orthognathic surgical procedure aimed to correct the sagittal and vertical discrepancies (four bimaxillary osteotomies, one mandibular advancement and chin osteotomy). In two more cases, orthognathic surgery is planned. Six patients are still in orthodontic treatment. Complications experienced with transpalatal distraction were palatal ulceration (one patient), and maxillary sinusitis (one patient). The most frequently encountered complication after transmandibular osteodistraction surgery was a submental hematoma and/or abscess (three patients). In one patient the apex of a lower central incisor was sectioned during the osteotomy, and endodontic treatment followed. In order to avoid this complication, a step osteotomy (between the canine and lateral incisor tooth cranially and in the midline/symphysis caudally) was performed in two patients instead of a midline osteotomy.

Currently, we can state that bimaxillary transverse osteodistraction surgery results in greater morbidity than four premolar extractions. The procedure requires general anaesthesia, compared with local anaesthesia for extraction therapy. Morbidity and stability is under investigation in the EUROCRAN project.

Conclusion

Severe crowding due to narrow apical bases can be corrected by four premolar extractions or by bimaxillary transverse osteodistraction. The first treatment option must deal with the adverse affects of increasing the intercanine distance, e.g. gingival recession and relapse of crowding, making permanent retention mandatory. Contraction of the dental arch results in retrusion of the lips and an increase in the unaesthetic buccal corridors. Bimaxillary transverse osteodistraction has potential advantages related to increased stability and smile aesthetics.

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