



Posterior transpalatal distraction with pterygoid disjunction: A short-term model study

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The transpalatal distractor (TPD) allows for maxillary expansion according to the concepts of distraction osteogenesis. Unlike tooth-borne, surgically assisted rapid palatal expansion devices, the bone-borne TPD is designed to avoid periodontal ligament compression, buccal root resorption, fenestration, tooth tipping, and orthodontic relapse during and after the expansion. When the distractor is placed on the palate at the level of the second premolar and pterygomaxillary disjunction is not performed, more expansion occurs in the anterior part of the maxilla than it does in the posterior. The aim of this investigation was to test the hypothesis that pterygomaxillary disjunction and placement of the TPD on the palate at the level of the first molars result in more parallel expansion of the maxillary segments. Twenty consecutive patients were included in a prospective way, and their predistraction and postdistraction models were electronically analyzed. The change in resistance and force application resulted, on average, in parallel segment expansion. The results showed that pterygomaxillary disjunction and posterior placement of the TPD are indicated for patients having transverse maxillary deficiency with lateroposterior crossbite. (*Am J Orthod Dentofacial Orthop* 2001;120:498-502)

Complex maxillofacial disharmonies in the vertical and sagittal dimension can be complicated by genuine or compensating transverse maxillary deficiency, resulting in unesthetic buccal corridors, bilateral crossbites, a tapered maxilla, and crowding.¹ The best treatment option would expand the maxilla without segmental tilting, orthodontic/orthopedic relapse, or dental/periodontal damage. The transpalatal distractor (TPD) (Surgi-Tec NV, L. Bauwenstraat 20, B-8200 Bruges)² meets these requirements. (The TPD is approved for use in Europe but is still under consideration by the FDA in the United States.) The TPD applies expansion forces high in the palatal vault (Fig 1), and segmental tilting in the frontal plane is therefore minimal.³ The bone-borne device thus avoids orthodontic relapse during and after the expansion. Periodontal ligament compression, buccal root resorption, fenestration, and extrusion of teeth are not problems as they are with tooth-anchored expanders.⁴⁻¹⁰ Distraction osteogen-

esis is a reliable technique for generating a callus that readily ossifies and prevents relapse.¹¹

A group of patients treated according to a standardized TPD protocol had previously been evaluated for initial segmental movements in the axial and frontal planes and correlating changes in arch perimeters.³ The results of that study indicated that there was more expansion in the anterior part of the maxilla than in the posterior part (ratio, 3:2). The aim of the study was to test the hypothesis that changing 2 parameters of this standard protocol (placing the TPD more posteriorly, at the level of the first molar, and separating the pterygoid processes from the palatal bone), would result in different, more parallel segmental movements. The null hypothesis was that there is no significant difference between intercanine, interpremolar, and intermolar expansion.

MATERIAL AND METHODS

The study group comprised 20 patients (12 females and 8 males), average age 20 years (range, 12-42 yrs). All patients were in the permanent dentition, and none had congenital craniofacial anomalies. No orthodontic appliances were used during the study, and bilateral expansion was achieved with the TPD. Informed consent was obtained for all patients. Osteotomies were performed under general anesthesia. A round #33 bur was used to transect the lateral support (zygomatic buttress), and a short, thick Lindemann bur was used for the anterior support (piriform aperture). A 1-cm wide, sharp osteotome (Leibinger; Freiburg, Germany) was used with the buccal sulcus approach to release the

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median support (midpalatal sutural area). Pterygoid disjunction was performed bilaterally with a curved osteotome (Gebruder Martin; Tuttlingen, Germany). The titanium abutment plates of the TPD were placed horizontally on the palatal vault overlying the palatal root of the first molar. The latency period was 1 week, and the expansion rate was one third mm daily.² The devices were removed 4 months postdistraction with local anesthesia only.

There were few problems and obstacles, and none of the patients experienced complications.¹² Both abutment plates had to be replaced to the second premolar level in 1 patient because the osteosynthesis screws loosened. In another patient, an osteosynthesis screw had to be replaced by a longer one. Both procedures were performed with local anesthesia only. In 5 patients, the distraction module loosened and had to be fixed again.

Maxillary study models were obtained before surgery and 2 to 3 weeks later, when the blocking screw (Fig 1) was inserted into the TPD to turn it into a fixed retainer. The models were trimmed with the base parallel to the occlusal plane. The points were marked on the models as described by Adkins et al.¹³ These were the most palatal points at the gingival margin of the first molars, the first premolars, and the canines; the contact points on the mesial surface of the first molars; the mesial surface of the first premolar; the distal surface of the central incisors; and the most facial point of the most prominent central incisor (Fig 2, A and B).

All models were photographed and digitized in 1 session to minimize error in landmark identification, photography, and digitization of the measurements. The models were photographed from an occlusal view with an AF35-70mm f/3.3-4.5 Nikon N90 camera (Nikon Inc, Melville, Nev) with a digital converter Kodak Professional DCS 420 (Eastman Kodak Company, Rochester, NY). A camera stand was used to support the models and to hold the camera at a fixed distance (34 cm) from the occlusal surface of the models. The images were taken in macro mode and stored in the digital format using the Adobe Photoshop 6.0 program (Adobe Systems Inc, San Jose, Calif). The digital color images were printed (Epson Stylus Photo 700, Epson Europe B.V., Amstelveen, The Netherlands) and the points digitized (Numonics Accugrid Backlighted Digitizer A43BL, Numonics Co, Montgomeryville, Pa). The software for cephalometric analysis was developed in the Orthodontic Department of the University of Zurich. The digitizer has been validated, and the working modalities were adapted accordingly.¹⁴

Indirect digitizing of digital pictures was done instead of direct measurement on the models with digi-

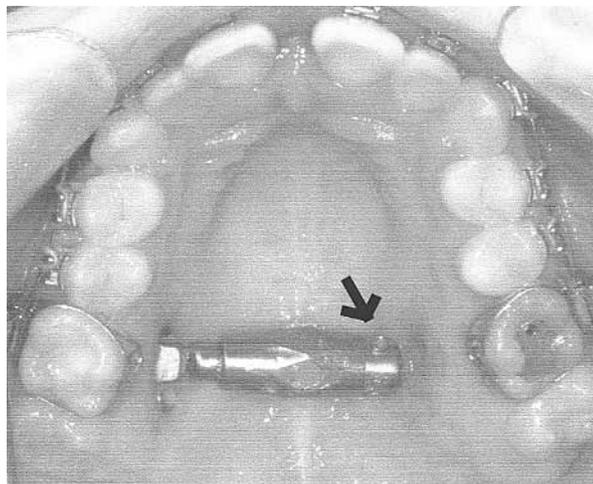


Fig 1. Palate of a 14.2-year-old girl, 2 months after TPD procedure. Necessary expansion is achieved, and orthodontic alignment has started. Module #3 is provided by blocking screw (arrow). Module fits bilaterally into abutment plate fixed with 5-mm long osteosynthesis screws in palatal bone, under mucoperiosteum. There are 4 types of interchangeable distraction modules, each having different and overlapping initial and final length.²

tal calipers for 2 reasons: the 3-dimensional aspect of the models could cause misreading, and the digital pictures had double magnification, halving the error in landmark identification.

StatMost for Windows software (DataMost Corporation, Salt Lake City, Utah) was used for the descriptive statistics, the *t* tests, and the regression analysis.

The error of measurement was calculated with the Dahlberg formula¹⁵ in a randomly chosen group of 10 patients. The method errors included the intrinsic errors of the digitizer,¹⁶ landmark identification, and the digitizing process. The degree of error (in percentage), the variance in the material, the error variance, and the percentage of the error variance compared with the total variance for selected parameters are shown in the Table. The method of measurement is acceptable because the errors of variance were less than 3% of the total variances.¹⁶

RESULTS

Expansion averaged 29.9% (SD 14.1%) at the level of the canines, 28.3% (SD 11.6) at the level of the first premolars, and 20.8% (SD 7.2) at the level of the first molars. The expansion percentages must be related to the original widths at the different levels to learn the differential movement of the anterior and posterior parts of the segments. The average original intercanine and interpremolar distances were 75% and 77.7%, respec-

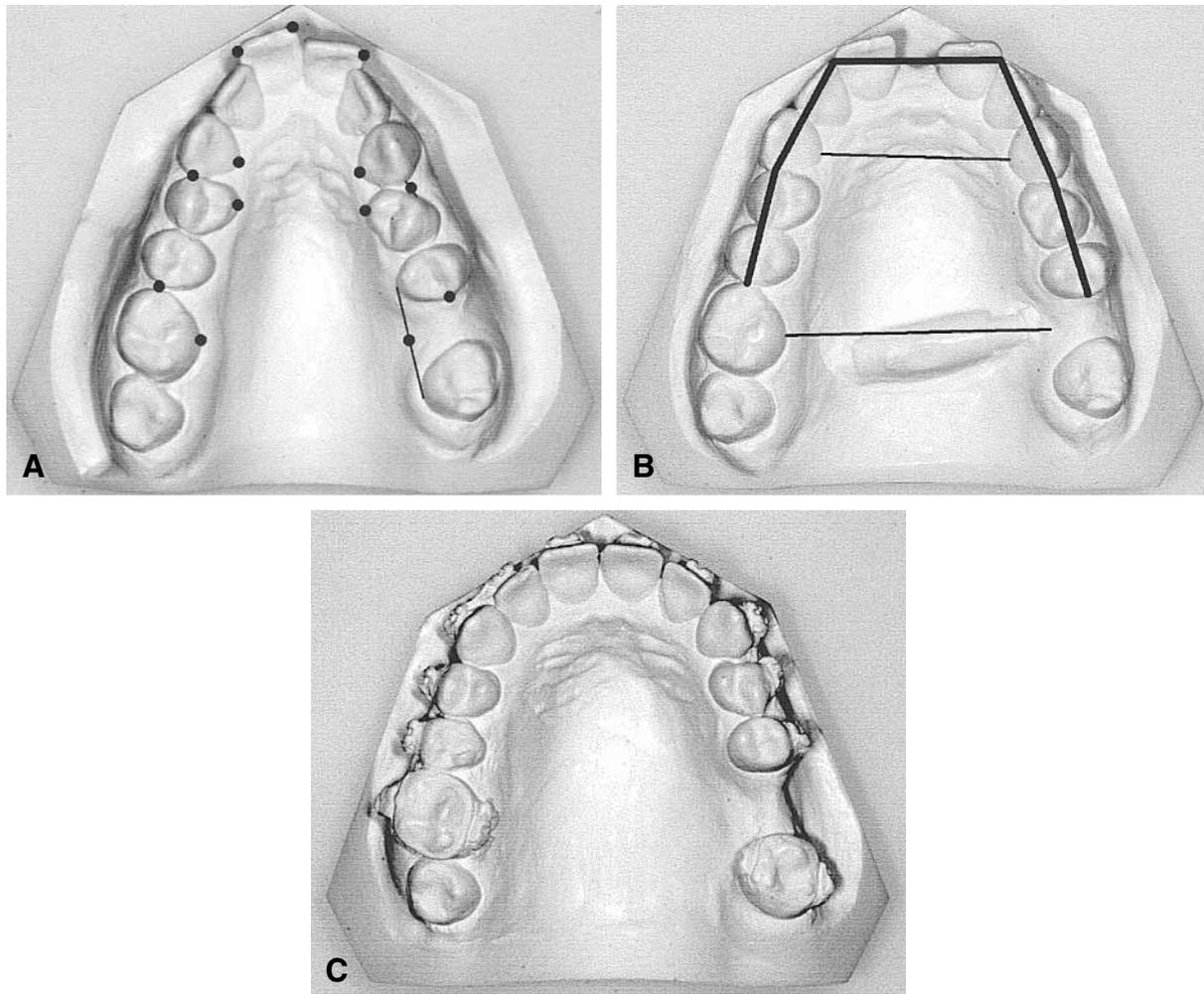


Fig 2. Maxillary models of a 25-year-old woman with severe transverse maxillary deficiency, treated with TPD at level of first molar and pterygomaxillary disjunction. **A**, Pretreatment model with markings of primary parameters. In region of missing left first molar, landmark was constructed. **B**, Immediate post-distraction model with secondary parameters: intercanine distance, intermolar distance, and arch perimeter. Some surgical leeway concerning orientation of TPD was noticed. **C**, Post-alignment model 6 months postoperatively.

tively, of the average original intermolar distance. The expansion ratio calculated to the metric unit was then 22.4% at the canine level, 21.9% at the first premolar level, and 20.8% at the first molar level. The canine-molar expansion ratio was 1:0.93.

There was a statistical difference (unpaired *t* test, confidence interval level 0.95) between the changes in the intercanine and the intermolar distance ($P = .017$), and between the changes in the interpremolar and the intermolar distance ($P = .01$), although not between the changes in the intercanine and the interpremolar distance ($P = .31$). The null hypothesis was rejected for the intercanine and intermolar expansion, the interpremolar and intermolar expansion, and the intercanine and inter-

premolar expansion. The differences were so small that from a clinical viewpoint the expansion can be considered almost parallel.

The resultant arch perimeter before any orthodontic intervention to correct the anteroposterior incisor position was a gain of 8.7% (SD, 2.3). The change in arch perimeter correlated well with the increase in intercanine width ($P < .001$, adjusted R^2 0.34) giving the equation "increase in arch perimeter in % = $-3.4 + 2.3 \times$ intercanine width in %." Linear regression analysis gave a similar relationship ($P < .001$, adjusted R^2 0.28; increase in arch perimeter in % = $4.9 + 1.6 \times$ interpremolar width in %). The change in arch perimeter did not correlate with the change in the intermolar width.

Table I. Variance in material and error variance

	Error degree in %	Variance in material	Error variance	% Error variance to variance in total sample
Inter canine distance	0.48	189.94	0.19	0.1
Inter premolar distance	0.32	132.28	0.04	0.03
Inter molar distance	0.38	29.47	0.06	0.23

DISCUSSION

The midpalatal suture, the zygomatic buttress, the piriform aperture, and the pterygomaxillary junction are the primary sites of resistance to maxillary expansion.¹⁷⁻²⁰ With increasing interdigitation in the palatal suture and maturation of the facial skeleton, the need to release the resistance in the suture and to section the lateral and posterior buttresses becomes obvious.^{21,22} The palatal mucoperiosteum constitutes a secondary site of resistance when immediate expansion is attempted, such as during a LeFort I osteotomy with midline split.²² Not only does distraction osteogenesis allow for predictable bone formation, but also the gradual expansion stimulates the regeneration of soft tissues (distraction histogenesis),²³ minimizing soft-tissue resistance over the expansion gap. With less focus on bone regeneration, this concept is also used in surgically assisted rapid palatal expansion (SA-RPE).

Since the TPD acts at the bony level, orthodontic movements and consequent relapse at the dental level should not occur. However, long-term stability needs to be proven.

A previous series of 20 patients treated with the TPD showed a statistically significant difference between intercanine and intermolar width increases. The canine-first molar expansion ratio was 3:2. However, the TPD device was placed at the level of the second premolar, and pterygomaxillary disjunction was not performed.³ SA-RPE with tooth-borne devices creates more widening between the molars than it does between the canines, even when pterygomaxillary disjunction is not performed.^{21,22} The canine-first molar expansion ratio in SA-RPE series is 2:3.^{21,22} Differential movements between the bony segments and the abutment teeth can be expected. This has been demonstrated for rapid palatal expansion.²⁴ With a bone-borne device, such as the TPD, the occlusal changes reflect the skeletal changes.

Distraction devices are levers, with the mechanical triad of fulcrum, resistance, and force. Force is characterized by magnitude and vector, the latter being determined by location and orientation. In transpalatal dis-

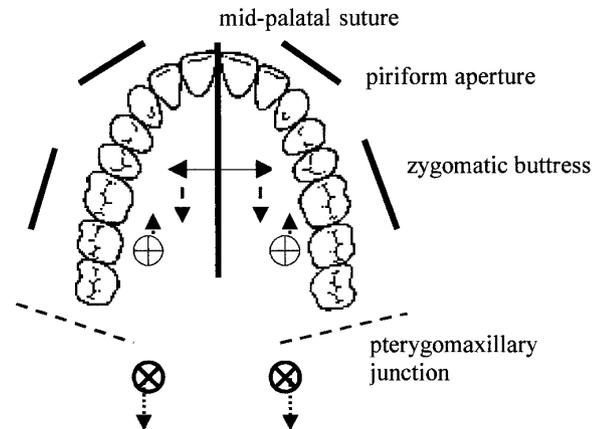


Fig 3. Biomechanics when distractor is placed at level of second premolar and pterygomaxillary disjunction is not performed,³ and when distractor is placed at level of first molar and disjunction is performed. \leftrightarrow Force applied by TPD, \otimes fulcrum, \oplus center of resistance, - - -surgical changes in current protocol (pterygomaxillary disjunction and more posterior placement of TPD), \downarrow changes in position of fulcrum and center of resistance.

traction osteogenesis with the TPD, the force vector is parallel to the axis of the distractor module. Action and reaction are contained in the device. Resistance is provided by the palatal mucoperiosteum and by any residual bony attachments or interferences. The center of resistance changes when pterygomaxillary disjunction is performed. In the patients studied by Pinto et al,³ the center of resistance was located more posteriorly than it was in our patients in relation to the site of the force application (Fig 3), and the fulcrum was anteriorly situated. This explains why patients in the current series showed nearly parallel expansion of the segments. Is it the combination of posterior location of the force and reducing the posterior resistance that causes these parallel movements, or is one or the other unnecessary? This is an issue for future research.

Placing the device near the main branch of the palatal artery did not result in arterial bleeding in our patients. The cortex in that area was thinner and more fragile than that encountered in the premolar area. The abutment plates sometimes had a more angulated position in the axial plane, predisposing to slippage of the module. On the other hand, avoiding a pterygomaxillary disjunction, although proven to be harmless from a surgeon's viewpoint, might help to reduce morbidity.

The original technique (TPD at the level of the first premolars, no pterygomaxillary disjunction) is indicated for patients with a tapered maxilla, anterior crowding, and little or no crossbite in the molar region. This combination is often encountered in cleft palate

patients. The benefits of transpalatal distraction for these patients require further investigation. Problems with the inclination of the palatal shelves and the scar tissue in the midline distraction gap can jeopardize the success of this technique. Indications for using the procedure as described in this study include lateroposterior crossbites with or without anterior crowding.

We performed unilateral expansions according to both regimens. From a clinical viewpoint, the segments behave similarly.

Seven of the 20 patients were under the age of 14 years, and all had Class II malocclusions and hypoplastic mandibles. Retroactive inquiries about the reasons for their referrals for TPD at this young age showed that their orthodontists were concerned about the vulnerability of the central incisors, that they planned to use functional appliances, and that standard rapid palatal expansion would postpone treatment for 6 months to 1 year.

CONCLUSIONS

Transpalatal distraction results in parallel expansion of the maxillary segments in the axial plane when the TPD device is placed at the level of the first molars and pterygomaxillary disjunction is performed.

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