ORIGINAL ARTICLE

Effect of the transpalatal arch during extraction treatment

Heather L. Zablocki,[a] James A. McNamara, Jr,[b] Lorenzo Franchi,[c] and Tiziano Baccetti[c]
Ann Arbor and Roseville, Mich, and Florence, Italy

Introduction: The transpalatal arch (TPA) can be used as an adjunct during orthodontic treatment to help control the movement of the maxillary first molars in 3 dimensions, including producing molar rotation and uprighting, maintaining transverse dimensions posteriorly during treatment, and maintaining leeway spaces during the transition of the dentition. The purpose of this retrospective cephalometric study was to test an additional function of the TPA: its ability to enhance orthodontic anchorage during extraction treatment. **Methods:** Records consisting of pretreatment and posttreatment cephalograms were gathered from several orthodontic practices that used an .018 × .025-in preangulated appliance. All patients were white and had 4 first premolars extracted as part of their treatment protocol. Patients were treated either with or without a TPA of the soldered Goshgarian design. Patients were excluded if headgear or any other auxiliary anchorage device beside the TPA was used during treatment. Matched samples of 30 patients were identified based on sex, age at the start of treatment, treatment duration, and cervical vertebral maturation stage. Statistical comparisons were made with nonparametric statistical tests. **Results:** Analysis of the changes from pretreatment to posttreatment for the TPA and the no-TPA groups showed no statistically significant differences in any of the variables examined. The net difference for both vertical and mesial movement of the maxillary first molar in relation to the maxilla between the 2 groups was 0.4 mm, with the no-TPA group in a more downward and forward position. **Conclusions:** Although the usefulness of the TPA for the abovementioned functions is not negated, it does not provide a significant effect on either the anteroposterior or the vertical position of the maxillary first molars during extraction treatment. (Am J Orthod Dentofacial Orthop 2008;133:852-60)

A controversial topic in orthodontics is the extraction of teeth and the effects on the skeleton, the dentoalveolar complex, and the soft-tissue profile. Teeth are removed in a variety of patterns, and many treatment protocols are used to achieve the desired treatment goals. The mechanics involved in the management of the extraction spaces depend on the amount of anchorage required. Maximum anchorage, when the first molars maintain their position and do not move into the extraction site, often is desirable in the maxillary arch. Several devices, both extraoral (extraoral traction) and intraoral (transpalatal arch, Nance holding arch), have been proposed to provide maximum anchorage.

The transpalatal arch (TPA) is a wire or bar spanning the palate connecting 2 bands on the maxillary first permanent molars. This auxiliary appliance is used widely to change or stabilize the position of the maxillary molars in 3 dimensions, including producing molar rotation and uprighting, stabilizing transverse dimensions posteriorly during treatment, and maintaining leeway spaces during the transition of the dentition. It also is used for additional anchorage during retraction of the anterior segments during extraction treatment.[1] Some clinicians theorize that splinting the 2 maxillary first molars together provides a rigid anchor that can be useful in preventing mesial movement of these teeth. Although this concept seems logical and appears to be commonly accepted, this supposition is based almost entirely on clinical experience rather than on hard science.

Only a few laboratory studies have been performed on the biomechanical aspects of various TPA designs.[2-4] There also has been a limited number of reports concerning the clinical management of the appliance.[1,5-8] Most articles focused on the correction of molar rotation, and all used removable TPAs, typically the Goshgarian design.[9] The only studies attempting to address the anchorage capabilities of the TPA used finite element analysis[10] or modified typodonts.[11] At best, these studies merely suggest that the TPA might be useful for providing anchorage; this anchorage function has not been addressed in the literature.

With the advent of implants,[12] onplants,[13] miniscrews,[14] and microimplants[15] to provide so-called "absolute" anchorage in orthodontic treatment, it is becoming increasingly relevant to determine the anchorage capabilities of commonly used orthodontic auxiliary anchorage devices. Why should a clinician perform an invasive and potentially more costly implant or microimplant procedure on a patient if traditional anchorage mechanics can provide consistent and comparable results? Some might say that implant or microimplant treatment used for anchorage is unnecessary when alternative appliances such as extraoral traction, the Nance holding arch, and the TPA are available. To date, however, no studies have quantified the anchorage capabilities of the TPA as the sole auxiliary appliance.

The purpose of this cephalometric study was a detailed comparison of patients treated with the extraction of 4 first premolars and a TPA with a matched sample treated without a TPA or any other auxiliary anchorage device, to quantify the anchorage capabilities of the TPA.

MATERIAL AND METHODS

Cephalometric records were gathered of patients who had 4 first premolars extracted and were treated either with or without a TPA. To obtain samples of adequate size, the records from several orthodontic practices were examined. Patients in both the TPA and the no-TPA groups were included if they met the following criteria: 4 first premolar extractions, Class I molar malocclusion, treated with .018 × .025-in pre-angulated appliances (Roth prescription) and continuous archwire mechanics, and white ancestry.

Patients who initially met the inclusion criteria were excluded from the study for any of the following factors: incomplete records, poor film quality or magnification problems, missing or ankylosed teeth anterior to the third molars, use of headgear or an auxiliary anchorage device other than the TPA during treatment,

Table I. Demographics of treatment time

|	Age at start (y)		Treatment time (y)	
Treatment group	*Mean*	*SD*	*Mean*	*SD*
TPA				
Boys (n = 11)	12.9	2.0	2.6	0.6
Girls (n = 19)	14.1	3.3	2.3	0.4
Total (n = 30)	13.7	2.9	2.4	0.5
No-TPA				
Boys (n = 11)	13.1	1.7	2.2	0.4
Girls (n = 19)	13.2	2.0	2.2	0.1
Total (n = 30)	13.1	1.9	2.2	0.4

banded or bonded maxillary second molars, or cervical vertebrae not visible.

The use of power chains, nickel-titanium coils, closing arches, and intermaxillary elastics was assumed, and the TPA had to be of the fixed (soldered) Goshgarian design.[1,9] Typically, the TPA remained in the patient's mouth for the duration of treatment, although occasionally it was removed a few months before the end of treatment to facilitate finishing the occlusion. Patients were excluded from the TPA sample if the TPA was removed before space closure or more than a few months before appliance removal. The most common reasons for exclusion were extraction patterns other than 4 first premolars, molar malocclusion other than Class I, nonwhite descent, missing or poor quality radiographs, and banded maxillary second molars. The final number of subjects in the TPA sample was 30 (Table I).

To assemble a matched no-TPA sample, the TPA sample was assessed for sex, age at the start of treatment, treatment duration, and pretreatment (T1) and posttreatment (T2) cervical vertebral maturation stage.[16]

Thirty qualifying patients who most closely matched those in the TPA sample based on the previously mentioned criteria were selected for the no-TPA group (Table I). In both groups, 57% of the patients went through their pubertal growth spurt during the T1 to T2 interval; 43% were in a postpubertal stage of mandibular growth. Of the patients meeting the inclusion criteria, the most common reasons for exclusion were extraction patterns other than 4 first premolars, molar malocclusion other than Class I, and nonwhite descent.
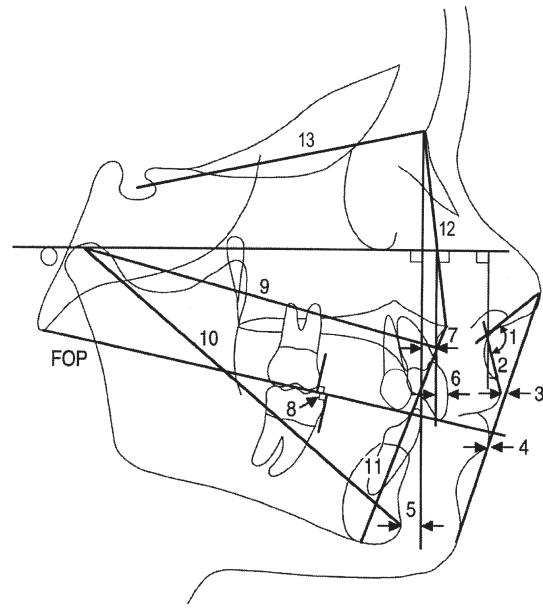
T1 and T2 lateral cephalograms were hand traced by one investigator (H.L.Z.), and landmark locations, anatomical contours, and tracing superimpositions were verified by a second examiner (J.A.Mc.). Disagreements were resolved to the satisfaction of both investigators. A customized digitization regimen (version
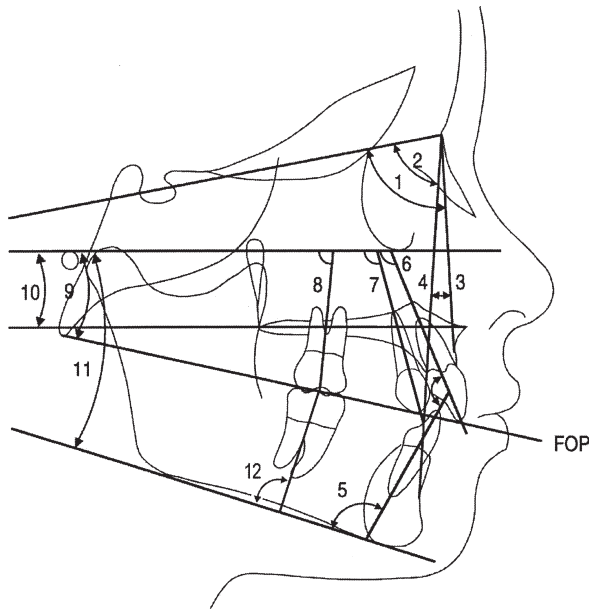
Fig 1. Cephalometric angular measurements: *1,* sella-nasion-Point A angle; *2,* sella-nasion-Point B angle; *3,* Point A-nasion-Point B; *4,* interincisal angle; *5,* mandibular central incisor to mandibular plane; *6,* maxillary central incisor to Frankfort horizontal; *7,* maxillary canine to Frankfort horizontal; *8,* maxillary first molar to Frankfort horizontal; *9,* Frankfort horizontal to occlusal plane; *10,* Frankfort horizontal to palatal plane; *11,* Frankfort horizontal to mandibular plane; *12,* mandibular first molar to mandibular plane; *FOP,* functional occlusal plane.

Fig 2. Cephalometric soft-tissue and linear measurements: *1,* nasolabial angle; *2,* cant of the upper lip; *3,* upper lip to E-plane; *4,* lower lip to E-plane; *5,* pogonion to nasion perpendicular; *6,* maxillary central incisor to Point A vertical; *7,* Point A to nasion perpendicular; *8,* molar relationship; *9,* midfacial length; *10,* mandibular length; *11,* anterior nasal spine to menton; *12,* nasion to anterior nasal spine; *13,* sella to nasion; *FOP,* functional occlusal plane.

2.5, Dentofacial Planner, Toronto, Ontario, Canada) including 78 landmarks and 4 fiducial markers was used for the analysis of the cephalometric data and the superimpositions of serial cephalograms. The magnification factor was standardized at 8%. Lateral cephalograms for each patient at T1 and T2 were digitized by using the Dentofacial Planner software, and 36 variables were generated for each film. A cephalometric analysis containing measures from the analyses of McNamara,[17] McNamara et al,[18,19] Ricketts,[20] Steiner,[21] and the Wits appraisal [22] was performed on each cephalogram analyzed in this study (Figs 1-3).

Regional superimpositions were derived by hand, and fiducial markers were placed in the maxilla and the mandible on the T1 tracing and transferred to the T2 tracing. The cranial bases were superimposed along the basion-nasion line and the posterior outline of the cranium, and registered at the most posterosuperior aspect of the pterygomaxillary fissure.[17,20] The maxillae were superimposed along the palatal plane by registering on the bony internal structures of the max-

illa superior to the incisors and the superior and inferior surfaces of the hard palate. The mandibles were superimposed posteriorly on the outlines of the mandibular canal and the tooth germs (before initial root formation) and anteriorly on the internal structures of the symphysis and the anterior contour of the chin.[17,20]

Statistical analysis

Means and standard deviations were calculated for age, duration of treatment, and all cephalometric measures at T1 and T2. Mean differences and standard deviations were calculated for the changes between T1 and T2. The data were analyzed with SPSS software (version 12.0, SPSS, Chicago, Ill) and SigmaStat for Windows (version 3.10, Systat Software, Point Richmond, Calif). Statistical significance was tested at $P < 0.05$. The error of the data collection method was described previously.[18]

The Shapiro-Wilks test for normality showed that not all variables were normally distributed. Therefore, the Mann-Whitney nonparametric statistical test was used to compare the starting forms and the changes between T1 and T2 for the TPA and the no-TPA
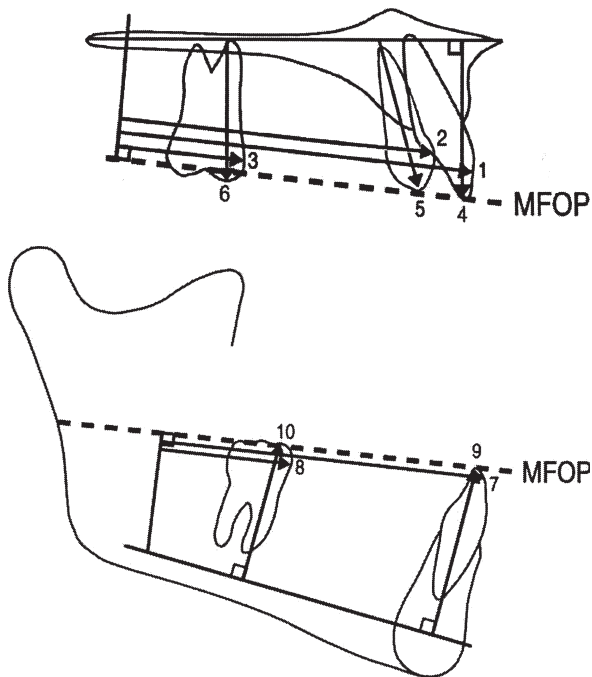
Fig 3. Cephalometric linear measurements: *1,* maxillary central incisor horizontal; *2,* maxillary canine horizontal; *3,* maxillary first molar horizontal; *4,* maxillary central incisor vertical; *5,* maxillary canine vertical; *6,* maxillary first molar vertical; *7,* mandibular central incisor horizontal; *8,* mandibular first molar horizontal; *9,* mandibular central incisor vertical; *10,* mandibular first molar vertical; *MFOP,* mean functional occlusal plane.

groups. On the basis of the numbers of subjects in the groups and the standard deviations of cephalometric variables, the power calculated for the study was 87% for treatment-induced differences of 2 mm or 2°.

RESULTS

Descriptive statistics calculated for the measurements at T1 for both groups are given in Table II. The starting forms for the 2 groups were similar. The TPA group had slightly longer maxillae and mandibles at T1. The sagittal positions of both the maxilla and the mandible of the TPA group as measured by SNA and SNB angles, respectively, were optimal, whereas the no-TPA group showed slight retrusion of both the maxilla and the mandible.[23] Dentally, the TPA group had a slightly increased distance (0.8 mm) from the mesial contact of the maxillary first molar to the mesial contact of the mandibular first molar. No other statistically significant differences were found at T1.

Descriptive statistics including means and standard deviations for the changes between T1 and T2 are shown in Table III. Composite tracings of cranial base

superimpositions illustrate the overall changes for the no-TPA group (Fig 4) and the TPA group (Fig 5) at T1 and T2. Regional superimpositions on maxillary fiducials indicating the movement of the maxillary incisors and molars for the 2 groups are shown in Figures 6 and 7, respectively. No statistically significant differences were found for any measurements between the groups. The net difference for mesial movement of the maxillary first molar in relation to the maxilla between the 2 groups was 0.4 mm, with the no-TPA group in a more forward position. The net difference for vertical movement of the maxillary first molar also was 0.4 mm, with the no-TPA group showing more downward movement.

DISCUSSION

Analysis of the changes between T1 and T2 for the 2 groups showed no statistically significant differences in any variable examined. Because no published studies have quantified the anchorage capabilities of the TPA, it was necessary to compare extraction studies that involved no additional auxiliary appliances. Investigations have looked into anchorage during treatment with Begg and edgewise appliances. The results are summarized in Table IV.

This study with edgewise appliances was similar to an investigation by Saelens and De Smit[24] that looked at the therapeutic changes in extraction vs nonextraction treatment with Begg appliances. Thirty patients with the 4 first premolars extracted were evaluated. Patients had either Class I or mild Class II or Class III malocclusions. Intra-arch elastics and anterior torquing auxiliaries were used during retraction, and interarch elastics were used mostly for Class II correction. The average age at the start of treatment was 11 years 10 months, and the average treatment time was 2 years 10 months. The results for the horizontal movement of the maxillary first molar (4.4 mm) are comparable to those of both the TPA and no-TPA groups in our study (4.1 and 4.5 mm, respectively). The results for the mesial movement of the mandibular first molar (5.7 mm) were much less than in the Begg study. The mandibular first molars moved mesially 2.6 mm in the TPA group and 3.0 mm in the no-TPA group (Table IV). This difference might be attributable to the inclusion of various molar malocclusions in the other study.

Less anchorage loss than that found in our study or that of Saelens and De Smit[24] has been reported. A study evaluating 32 patients with the extraction of 4 first premolars and Begg appliances found a mean mesial maxillary first molar movement of 2.7 mm (Table IV).[25] The details described were vague, however, making any comparison with our study difficult.

Table II. Comparison of starting forms (T1)

Cephalometric measures	TPA n = 30		No-TPA n = 30		Net difference	Significance
	Mean	SD	Mean	SD		
Maxillary skeletal						
Co-Pt A (mm)	91.8	4.4	89.1	4.3	2.7	*
SNA (°)	81.7	3.0	79.6	3.1	2.1	*
Pt A to nasion perp (mm)	0.7	3.0	−0.8	3.0	1.5	NS
Mandibular skeletal						
Co-Gn (mm)	117.1	5.4	113.1	5.9	4.0	*
SNB (°)	77.6	2.5	75.7	3.1	1.9	*
Pg to nasion perp (mm)	−6.1	4.8	−8.4	5.1	2.3	NS
Maxillary/mandibular						
Wits (mm)	1.0	3.0	1.1	2.3	0.1	NS
Maxillary/mandibular difference (mm)	25.3	4.4	24.0	3.7	1.3	NS
ANB (°)	4.1	2.3	3.9	1.7	0.2	NS
Vertical skeletal						
FH to occlusal plane (°)	9.9	2.9	10.6	4.6	0.7	NS
FH to palatal plane (°)	1.0	3.5	1.5	3.0	0.5	NS
MPA (°)	28.5	5.3	28.1	5.2	0.4	NS
N to ANS (mm)	52.7	2.9	52.2	3.2	0.5	NS
ANS to Me (mm)	70.3	6.0	70.4	5.6	0.1	NS
Interdental						
Overbite (mm)	2.9	2.0	3.5	1.7	0.6	NS
Overjet (mm)	5.8	1.9	5.7	1.5	0.1	NS
Interincisal angle (°)	125.0	8.2	123.5	8.0	1.5	NS
Molar relationship (mm)	2.6	1.2	1.8	1.0	0.8	*
Maxillary dentoalveolar						
U1 to Pt A vertical (mm)	6.2	1.7	6.1	1.8	0.1	NS
U1 to FH (°)	114.2	4.8	114.2	6.4	0.0	NS
U6 to FH (°)	79.8	4.2	78.1	4.7	1.7	NS
Mandibular dentoalveolar						
L1 to Pt A-pogonion (mm)	3.3	2.3	3.5	2.1	0.2	NS
L1 to MP (°)	92.3	7.0	94.1	5.7	1.8	NS
L6 to MP (°)	87.0	3.5	87.3	4.1	0.3	NS
Soft tissue						
UL to E-plane (mm)	−5.2	2.8	−4.3	2.3	0.9	NS
LL to E-plane (mm)	−1.0	3.0	−0.1	2.8	0.9	NS
Nasolabial angle (°)	118.1	10.9	113.4	13.9	4.7	NS
Cant of upper lip (°)	2.5	9.5	4.6	9.4	2.1	NS

NS, Not significant; *perp,* perpendicular; *FH,* Frankfort horizontal; *U1,* maxillary central incisor; *U6,* maxillary first molar; *L1,* mandibular central incisor; *L6,* mandibular first molar; *MP,* mandibular plane; *UL,* upper lip; *LL,* lower lip.
*P <0.05.

Three studies investigated extraction treatment with the edgewise appliance. Through lateral cephalometric analysis, Staggers[26] evaluated 22 patients treated at the West Virginia University Department of Orthodontics with the extraction of 4 first premolars. Thirteen of the patients were Class I, and 9 were Class II Division 1. They ranged in age from 9 to 16 years, and average treatment time was 3.1 years. Treatment mechanics other than edgewise appliances were not specified. The results for mean horizontal anchorage loss were similar to the results in this study. Maxillary first molar horizontal and mandibular first molar horizontal were reported as 4.8 and 3.7 mm, respectively. Vertical molar change also was evaluated in the Staggers study.[26] Mean extrusion of the maxillary first molar was 3.0 mm, and mean extrusion of the mandibular first molar was 3.4 mm (Table IV). The mean vertical changes for both the maxillary and mandibular molars in the Staggers study[26] were greater than we found, particularly for the maxillary molars. The maxillary first molar extrusions were 1.4 mm in the TPA group and 1.8 mm in the no-TPA group. Extrusion of the mandibular first molar did not show as great a difference, with 3.2 mm in the TPA group and 2.9 mm in the no-TPA group. This difference could be explained because the average age of the

Table III. Comparison of changes (T1-T2)

Cephalometric measures	TPA n = 30		No-TPA n = 30		Net difference	Significance
	Mean	SD	Mean	SD		
Maxillary skeletal						
Co-Pt A (mm)	1.2	1.9	1.4	2.0	0.2	NS
SNA (°)	−1.1	1.5	−1.5	1.3	0.4	NS
Pt A to nasion perp (mm)	−1.2	1.7	−1.9	1.4	0.7	NS
Mandibular skeletal						
Co-Gn (mm)	5.2	3.6	6.3	3.4	1.1	NS
SNB (°)	−0.6	1.3	−0.4	1.3	0.2	NS
Pg to nasion perp (mm)	−0.2	2.1	−0.1	2.2	0.1	NS
Maxillary/mandibular						
Wits (mm)	−0.6	2.6	−0.8	2.0	0.2	NS
Max/mand difference (mm)	4.0	2.5	4.8	2.3	0.8	NS
ANB (°)	−0.5	1.5	−1.2	1.2	0.7	NS
Vertical skeletal						
FH to occlusal plane (°)	−1.9	2.9	−2.5	3.0	0.6	NS
FH to palatal plane (°)	−0.9	2.3	−0.6	1.5	0.3	NS
MPA (°)	0.5	1.6	0.4	1.7	0.1	NS
N to ANS (mm)	2.3	2.5	2.7	1.9	0.4	NS
ANS to Me (mm)	4.0	3.3	4.1	2.2	0.1	NS
Interdental						
Overbite (mm)	−0.3	1.8	−1.1	2.0	0.8	NS
Overjet (mm)	−1.5	1.7	−1.8	1.3	0.3	NS
Interincisal angle (°)	10.0	9.6	6.9	10.8	3.1	NS
Molar relationship (mm)	−0.3	1.2	0.0	2.1	0.3	NS
Maxillary dentoalveolar						
U1 to Pt A vertical (mm)	−2.7	1.3	−2.8	1.8	0.1	NS
U1 horizontal (mm)	−2.8	1.3	−3.2	1.6	0.4	NS
U1 vertical (mm)	1.3	1.7	1.1	1.8	0.2	NS
U6 horizontal (mm)	4.1	1.5	4.5	2.0	0.4	NS
U6 vertical (mm)	1.4	1.7	1.8	1.1	0.4	NS
U1 to FH (°)	−6.5	6.4	−3.1	7.8	3.4	NS
U6 to FH (°)	3.2	2.9	2.4	3.6	0.8	NS
Mandibular dentoalveolar						
L1 to Pt A-pogonion (mm)	−2.0	1.9	−2.1	1.9	0.1	NS
L1 horizontal (mm)	−2.6	1.5	−3.0	1.3	0.4	NS
L1 vertical (mm)	2.7	2.4	2.4	1.5	0.3	NS
L6 horizontal (mm)	2.6	1.4	3.0	2.1	0.4	NS
L6 vertical (mm)	3.2	2.0	2.9	1.5	0.3	NS
L1 to MP (°)	−4.0	5.3	−4.3	5.5	0.3	NS
L6 to MP (°)	−2.3	2.7	−2.5	4.3	0.2	NS
Soft tissue						
UL to E-plane (mm)	−3.4	2.2	−3.0	2.3	0.4	NS
LL to E-plane (mm)	−2.9	2.1	−3.2	1.9	0.3	NS
Nasolabial angle (°)	4.4	7.9	6.3	9.5	1.9	NS
Cant of upper lip (°)	−8.1	6.7	−8.7	7.6	0.6	NS

NS, Not significant; *perp,* perpendicular; *FH,* Frankfort horizontal; *U1,* maxillary central incisor; *U6,* maxillary first molar; *L1,* mandibular central incisor; *L6,* mandibular first molar; *MP,* mandibular plane; *UL,* upper lip; *LL,* lower lip.
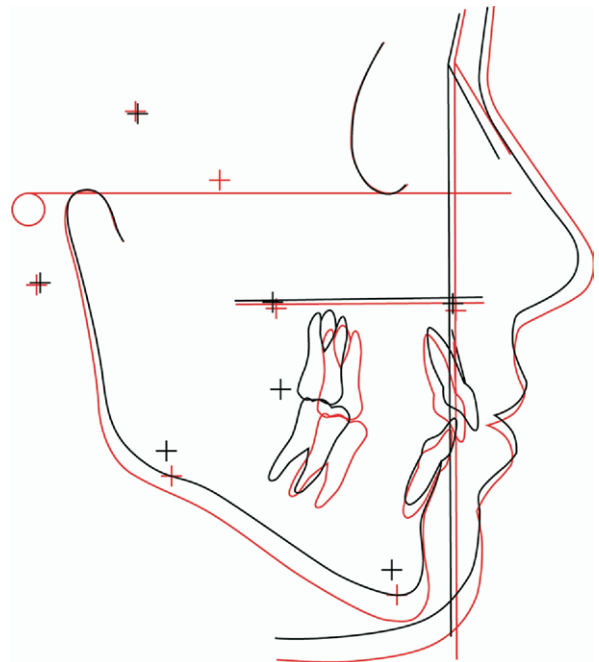
patients in the Staggers study[26] was younger, and the average treatment time was 5 to 7 months longer than in our study.

Another study of 4 first premolar extraction treatment with edgewise appliances used the pitchfork analysis of Paquette et al[27] to quantify molar movement; the 33 patients, however, had Class II Division 1 malocclusions. The mean mesial movements were 2.5 mm (−3.1 mm bodily, 0.6 mm tipping) for the maxillary first molar and 3.3 mm (4.6 mm bodily, −1.3 mm tipping) for the mandibular first molar (Table IV). The total correction reported was 2.8 mm. In this study, for both treatment groups, the maxillary molars moved more mesially, and the mandibular molars moved less
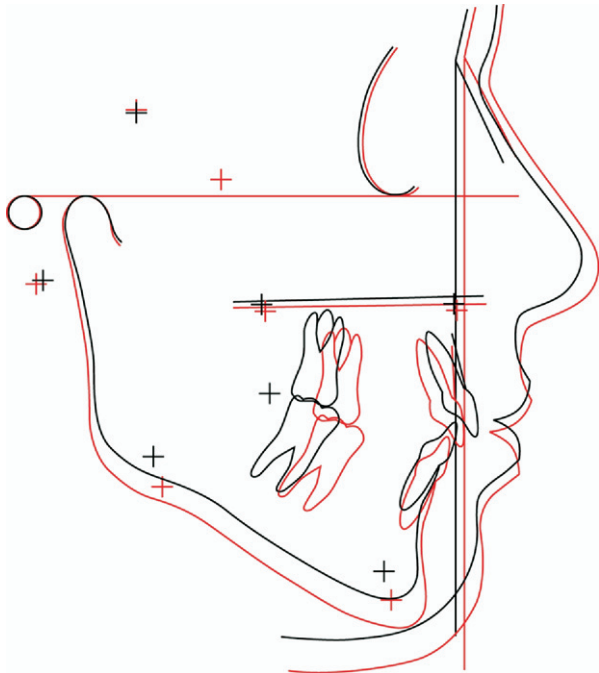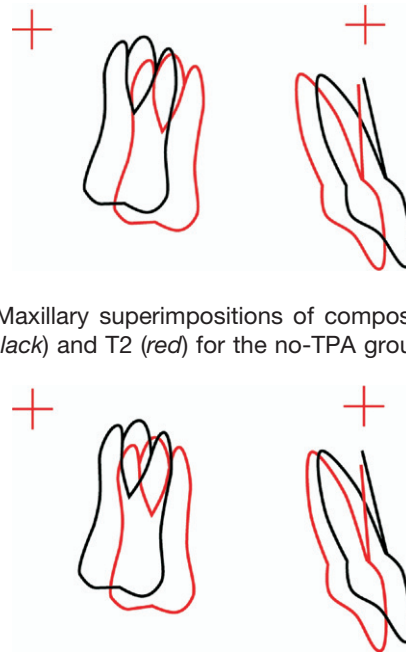
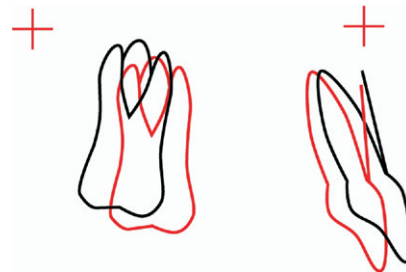**Fig 4.** Superimposition of composite cephalometric forms for the no-TPA group at T1 (*black*) and T2 (*red*).

Fig 6. Maxillary superimpositions of composite forms at T1 (*black*) and T2 (*red*) for the no-TPA group.

Fig 7. Maxillary superimpositions of composite forms at T1 (*black*) and T2 (*red*) for the TPA group.

with edgewise appliances was also by Staggers,[28] who examined only vertical changes after premolar extractions. Thirty-eight patients with Class I molar malocclusions and 4 first premolars removed were evaluated cephalometrically. The mean age at the beginning of treatment was 14.5 years (range, 9-28 years). For the maxillary first molar, the mean vertical change was 2.0 mm (SD, 2.0 mm). The mean vertical change for the mandibular first molar was 2.7 mm (SD, 2.0 mm) (Table IV). Our values for extrusion of the maxillary and mandibular first molars were similar to those of Staggers.[28]

The results from this study are consistent with the findings of extraction studies in the literature. In addition, patients treated with the TPA as an auxiliary anchorage device did not show a significant difference from those treated with standard preadjusted appliances without additional anchorage. The amount of forward movement during treatment also was slightly greater in the no-TPA group. However, these differences were not statistically significant.

Overjet did not change significantly from T1, and the patients were not bialveolar protrusive, suggesting that the extraction space was used mainly to correct crowding. The mandibular incisors finished in an upright position, and the first molars remained in a Class I relationship. If the TPA actually had provided maximum anchorage, it can be calculated that the lack of

Fig 5. Superimposition of composite cephalometric forms for the TPA group at T1 (*black*) and T2 (*red*).

mesially. The total correction was much less for both groups. These differences are compatible with correction of Class I vs Class II molar malocclusions.

The third study evaluating premolar extractions

Table IV. Comparison of mean anchorage loss reported in the literature

Author	Sample	Treatment	U6 horz	L6 horz	U6 vert	L6 vert
Allen[25]	32	Begg	2.7 mm	NR	NR	NR
Saelens and De Smit[24]	30	Begg	4.4 mm	5.7 mm	NR	NR
Lotzof et al[29]	10	Begg	1.7 mm	NR	NR	NR
Lotzof et al[29]	10	Edgewise	2.3 mm	NR	NR	NR
Staggers[26]	22	Edgewise	4.8 mm	3.7 mm	3.0 mm	3.4 mm
Paquette et al[27]	33	Edgewise	2.5 mm	3.3 mm	NR	NR
Staggers[28]	38	Edgewise	NR	NR	2.0 mm	2.7 mm
Zablocki et al*	30	Edgewise	4.5 mm	3.0 mm	1.8 mm	2.9 mm
Zablocki et al*	30	Edgewise/TPA	4.1 mm	2.6 mm	1.4 mm	3.2 mm

U6 horz, Maxillary first molar horizontal; *L6 horz,* mandibular first molar horizontal; *U6 vert,* maxillary first molar vertical; *L6 vert,* mandibular first molar vertical; *NR,* not reported.
*This study.

movement of the posterior segments would have resulted in 5.2 and 6.9 mm of retraction of the mandibular and maxillary incisors, respectively. This amount of retraction could have produced negative effects on the profiles of our patients because their primary problem was crowding, not protrusion. Significant retraction would be more beneficial for bialveolar protrusion. Maximum or absolute anchorage then would be indicated as well as an anchorage device capable of providing such support, such as implants or miniscrew implants.[12-15]

CONCLUSIONS

The TPA has been used successfully for decades during routine orthodontic treatment for various purposes, including molar rotation, buccal root torque, stabilization of the transverse dimension posteriorly, and maintenance of the leeway space in the maxilla. In this study, we evaluated an assumed additional function of the TPA—as an anchoring device in extraction patients, with the maxillary first molars splinted together by the connecting wire or bar of the appliance. The assumption that the TPA reduces forward movement of the maxillary first molars during retraction of anterior teeth was not substantiated. The subjects treated with a TPA showed no significant difference from those treated without a TPA.

The results of this retrospective cephalometric investigation indicate that the TPA has no significant effect on either the anteroposterior or the vertical position of the maxillary first molars during extraction treatment. This study does not suggest, however, that the TPA should be considered an unnecessary tool in the treatment of orthodontic patients, because of its other functions. Rather, the clinician should recognize its limitations in maintaining anchorage and seek alternative methods (eg, microimplants) if maximum or absolute anchorage is desired.

REFERENCES

1. McNamara JA Jr, Brudon WL. Orthodontics and dentofacial orthopedics. Ann Arbor, Mich: Needham Press; 2001.
2. Burstone CJ, Koenig HA. Precision adjustment of the transpalatal lingual arch: computer arch form predetermination. Am J Orthod 1981;79:115-34.
3. Gollner P, Bantleon HP, Ingervall B. Force delivery from a transpalatal arch for the correction of unilateral first molar cross-bite. Eur J Orthod 1993;15:411-20.
4. Ingervall B, Honigl KD, Bantleon H. Moments and forces delivered by transpalatal arches for symmetrical first molar rotation. Eur J Orthod 1996;18:131-9.
5. Ten Hoeve A. Palatal bar and lip bumper in nonextraction treatment. J Clin Orthod 1985;19:272-91.
6. Gunduz E, Zachrisson BU, Honigl KD, Crismani AG, Bantleon HP. An improved transpalatal bar design. Part I. Comparison of moments and forces delivered by two bar designs for symmetrical molar derotation. Angle Orthod 2003;73:239-43.
7. Dahlquist A, Gebauer U, Ingervall B. The effect of a transpalatal arch for the correction of first molar rotation. Eur J Orthod 1996;18:257-67.
8. Ingervall B, Gollner P, Gebauer U, Frohlich K. A clinical investigation of the correction of unilateral first molar crossbite with a transpalatal arch. Am J Orthod Dentofacial Orthop 1995;107:418-25.
9. Goshgarian RA. Orthodontic palatal arch wires. United States Government Patent Office; 1972.
10. Bobak V, Christiansen RL, Hollister SJ, Kohn DH. Stress-related molar responses to the transpalatal arch: a finite element analysis. Am J Orthod Dentofacial Orthop 1997;112:512-8.
11. Anic S, Slaj M, Muretic Z. Computer anchorage analysis of digitized picture of modified typodont. Coll Antropol 1998;22:15-24.
12. Huang LH, Shotwell JL, Wang HL. Dental implants for orthodontic anchorage. Am J Orthod Dentofacial Orthop 2005;127:713-22.

13. Janssens F, Swennen G, Dujardin T, Glineur R, Malevez C. Use of an onplant as orthodontic anchorage. Am J Orthod Dentofacial Orthop 2002;122:566-70

14. Kanomi R. Mini-implant for orthodontic anchorage. J Clin Orthod 1997;31:763-7.

15. Sung JH, Kyung HM, Bae SM, Park HS, Kwon OW, McNamara JA Jr. Microimplants in orthdontics. Daegu, Korea: Dentos; 2006.

16. Baccetti T, Franchi L, McNamara JA Jr. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. Semin Orthod 2005;11:119-29.

17. McNamara JA Jr. A method of cephalometric evaluation. Am J Orthod 1984;86:449-69.

18. McNamara JA Jr, Bookstein FL, Shaughnessy TG. Skeletal and dental changes following functional regulator therapy on class II patients. Am J Orthod 1985;88:91-110.

19. McNamara JA Jr, Howe RP, Dischinger TG. A comparison of the Herbst and Frankel appliances in the treatment of Class II malocclusion. Am J Orthod Dentofacial Orthop 1990;98:134-44.

20. Ricketts RM. Perspectives in the clinical application of cephalometrics. The first fifty years. Angle Orthod 1981;51:115-50.

21. Steiner CC. Cephalometrics for you and me. Am J Orthod 1953;39:729-55.

22. Jacobson A. The "Wits" appraisal of jaw disharmony. Am J Orthod 1975;67:125-38.

23. Riolo ML, Moyers RE, McNamara JA Jr, Hunter WS. An atlas of craniofacial growth: cephalometric standards from the University School Growth Study. Monograph 2. Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development; University of Michigan; 1974.

24. Saelens NA, De Smit AA. Therapeutic changes in extraction versus non-extraction orthodontic treatment. Eur J Orthod 1998;20:225-36.

25. Allen W. Evaluation of maxillary anchorage during third stage of Begg light-wire technique [abstract]. Am J Orthod 1969;55:92.

26. Staggers JA. A comparison of results of second molar and first premolar extraction treatment. Am J Orthod Dentofacial Orthop 1990;98:430-6.

27. Paquette DE, Beattie JR, Johnston LE Jr. A long-term comparison of nonextraction and premolar extraction edgewise therapy in "borderline" Class II patients. Am J Orthod Dentofacial Orthop 1992;102:1-14.

28. Staggers JA. Vertical changes following first premolar extractions. Am J Orthod Dentofacial Orthop 1994;105:19-24.

29. Lotzof LP, Fine HA, Cisneros GJ. Canine retraction: a comparison of two preadjusted bracket systems. Am J Orthod Dentofacial Orthop 1996;110:191-6.