CASE REPORT

Rapid Maxillary Expansion Using Palatal Implants

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Rapid maxillary expansion through midpalatal suture opening often results in undesirable buccal tipping of the posterior teeth supporting the expansion appliance.[1-5] This orthodontic effect accounts for about half of the expansion screw opening in the deciduous or mixed dentition and two-thirds of that in the permanent dentition.[3] The amount of orthodontic movement increases with patient age, as the orthopedic effect of the expander decreases.[6]

Orthodontic expansion can have periodontal consequences, including root resorption at the buccal aspects of the supporting teeth,[7] buccal dehiscences,[7] and a greater long-term risk of gingival recession.[2,3,7-20] Minimizing buccal tooth movement during expansion would increase the orthopedic effect, thus maximizing the gain in arch perimeter and the stability of expansion, while avoiding undesirable periodontal side effects. This article describes a new system for rapid maxillary expansion that incorporates palatal implants to restrict buccal tipping.

Diagnosis and Treatment

A 14-year-old female presented with a Class I malocclusion and unilateral posterior crossbite (Fig. 1). The treatment plan consisted of rapid maxillary expansion using a Hyrax* expander, supported by the permanent first molars and by palatal implants** placed bilaterally between the first and second premolars (Fig. 2). The implants (3mm in diameter, 7mm long) were specifically designed for this procedure; they are made from a type of titanium that resists

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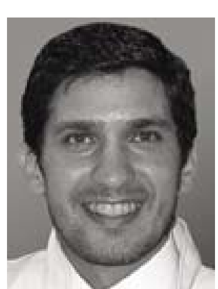
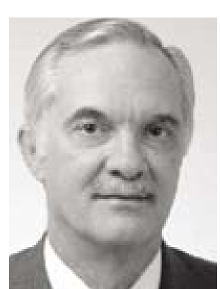

Dr. Navarro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osseointegration, so they can easily be removed after expansion. Conventional orthodontic miniscrews would have compressed the expander against the palatal mucosa, causing tissue ischemia and necrosis.

The implants were placed obliquely to avoid contact with important anatomical structures such as the nasal cavity, maxillary sinuses, and dental roots, and were inclined lingually to resist transverse expansion forces.[21,22] After surgery, an impression was taken for transfer of the appliance setup. Two stainless steel rings, which would be attached to the implants with screws, were fitted to the implant analogs on the cast, and the anterior extensions of the Hyrax expander were soldered to the rings.

Palatal expansion was begun one month after the implant surgery (Fig. 3). The Hyrax expander was opened one-half turn per day,[2] up to a total of 6mm over 15 days. Spiral computed tomography (CT) was performed before maxillary expansion and after four months of retention following removal of the expander. The

Fig. 1 14-year-old female patient with Class I malocclusion and unilateral posterior crossbite before treatment.

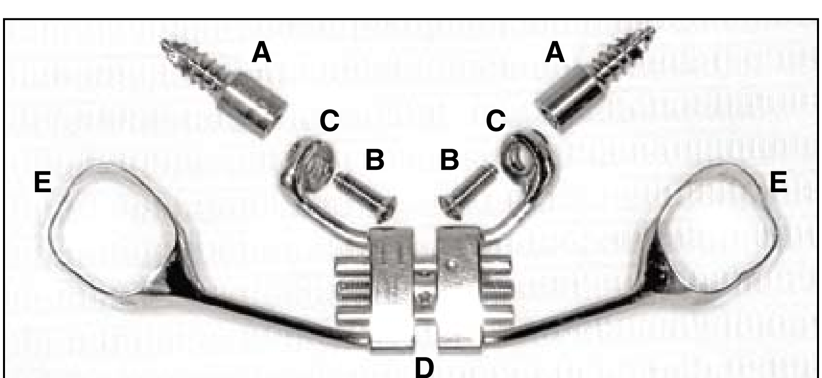


Fig. 2 Appliance components. A. Titanium implants (3mm × 7mm). B. Fixation screws. C. Stainless steel rings. D. Hyrax expander. E. Orthodontic bands.

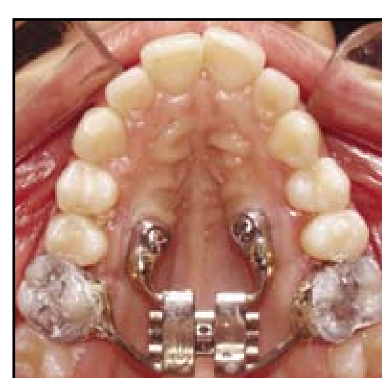


Fig. 3 Palatal expander in place at start of treatment.

spiral CT machine*** had an FC 30 scanning filter, a field of view of 12.6cm × 12.6cm, a matrix of 512 × 512 pixels, and a window width of 2,400 Hounsfield units (HU) with a center of 1,300HU. It was set at 120kV and 100mA, with a scanning time of 1 second per section, and 1mm-thick axial sections were performed parallel to the palatal plane, comprising the dentoalveolar and basal areas of the maxilla, up to the lower

***Xvision EX, Toshiba America Medical Systems, Inc., 2441 Michaelle Drive, Tustin, CA 92680; www.medical.toshiba.com.

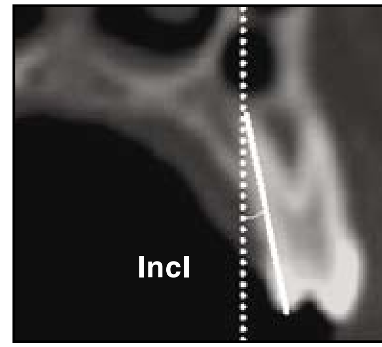


Fig. 6 Measurement of tooth inclination (Incl), corresponding to angle between line perpendicular to lower border of CT image and line passing through palatal cusp tip and palatal root apex.

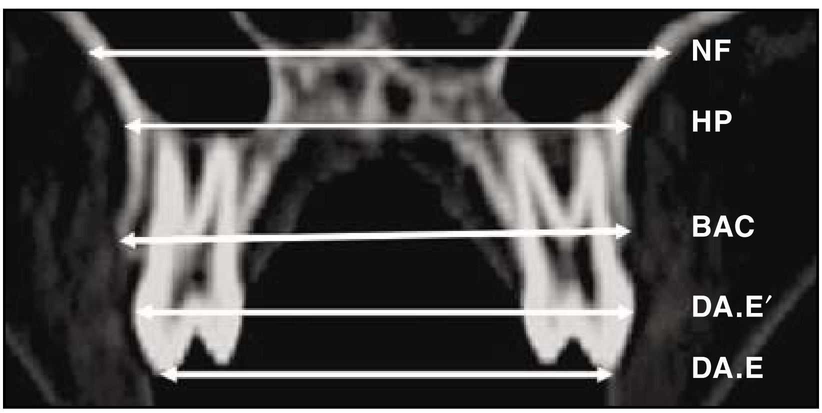


Fig. 4 Measurement of external maxillary width. NF = maxillary width parallel to lower border of computed tomographic (CT) image and tangent to most superior level of nasal floor; HP = maxillary width parallel to lower border of CT image and tangent to hard palate; BAC = maxillary width at level of buccal alveolar crest; DA.E′ = dental arch external width at most prominent area of buccal aspect of posterior teeth; DA.E = dental arch external width at level of buccal cusp tips.

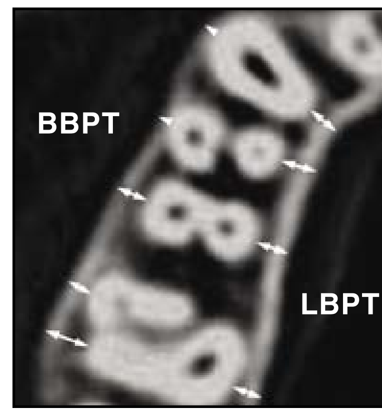


Fig. 7 Measurement of maxillary posterior bone plate thickness. BBPT = buccal bone plate thickness from external border of buccal cortical plate to center of buccal aspect of canine, first premolar, and second premolar roots, and to center of mesial and distobuccal first molar roots, on both sides; LBPT = lingual bone plate thickness from external border of palatal cortical plate to center of palatal aspect of canine, first premolar, and second premolar roots, and to center of palatal first molar root, on both sides.

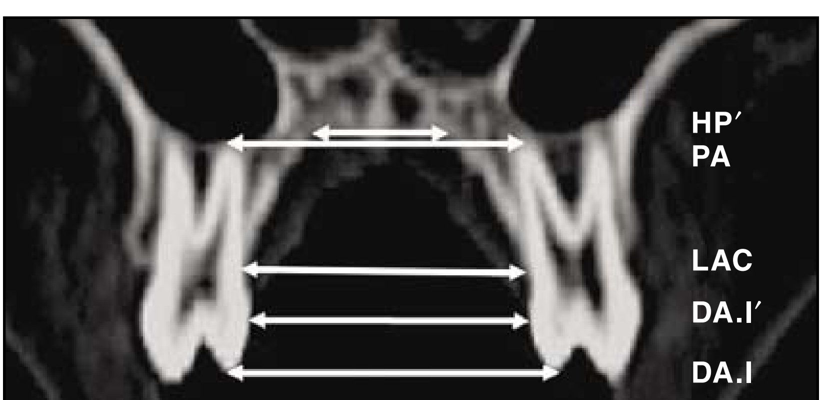


Fig. 5 Measurement of internal maxillary width. HP′ = hard palate width; PA = width between tooth apices on palatal roots of posterior teeth; LAC = maxillary width between lingual alveolar crests; DA.I′ = dental arch internal width at most prominent area of lingual aspect of posterior teeth; DA.I = dental arch internal width at level of palatal cusp tips.

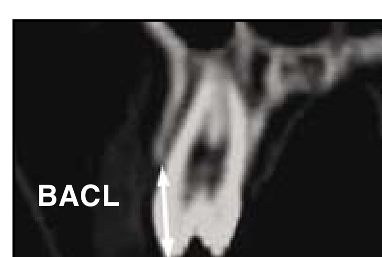


Fig. 8 Measurement of maxillary posterior buccal alveolar crest level (BACL), from buccal cusp tip to buccal alveolar crest.

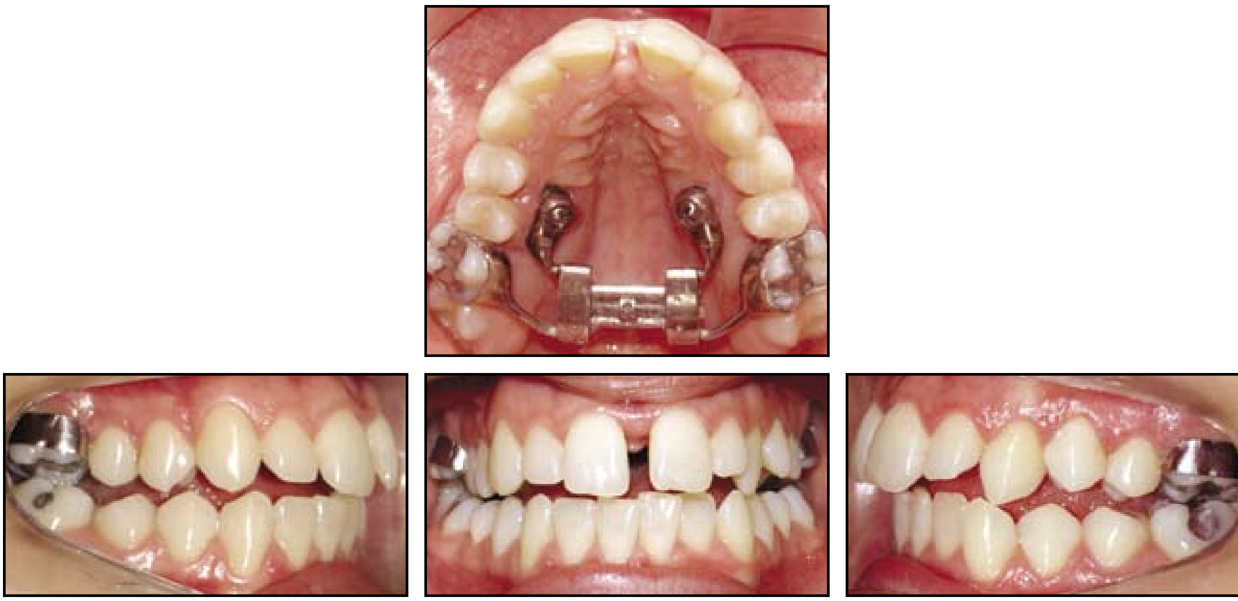


Fig. 9 Patient after 15 days of expansion.

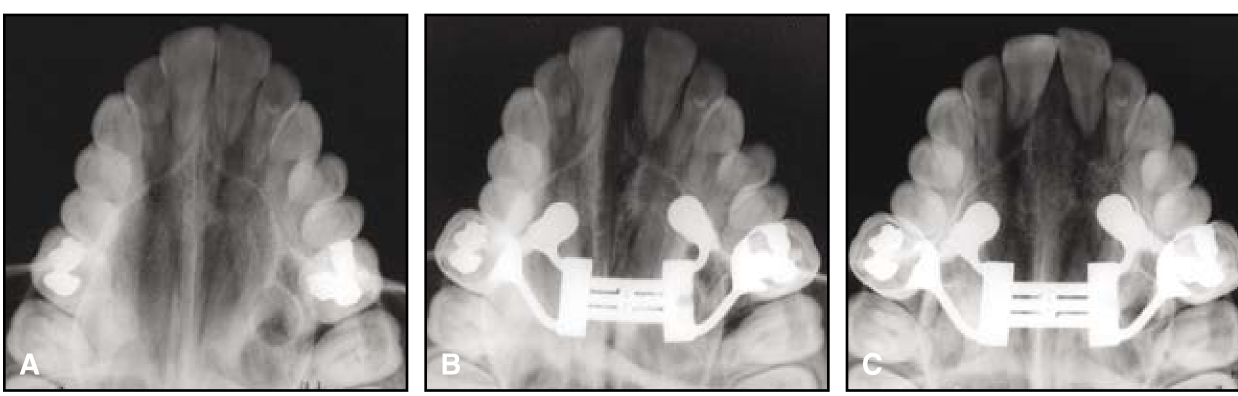


Fig. 10 A. Before treatment. B. Immediately after expansion. C. Four months after expansion.

third of the nasal cavity. Multiplanar reconstruction was then used to measure maxillary transverse dimensions, posterior tipping, buccal and lingual bone plate thicknesses, and buccal alveolar crest levels before and after expansion, according to the protocol developed by Garib and colleagues[1,23] (Figs. 4-8).

Treatment Results

The maxillary expansion procedure was successful in opening the midpalatal suture and correcting the posterior crossbite (Figs. 9,10). A midline diastema appeared after 12 days of expansion screw activation.

In the first molar region, where the transverse expansion was tooth-supported, the increase in maxillary width at the dental arch (DA) level was close to the amount of screw activation (6mm), but the change at the nasal floor (NF) level was only .8mm (Table 1). The increases in maxillary width at the level of the hard palate (HP and HP′) and at the buccal and lingual alveolar crests (BAC and LAC) were of interme-

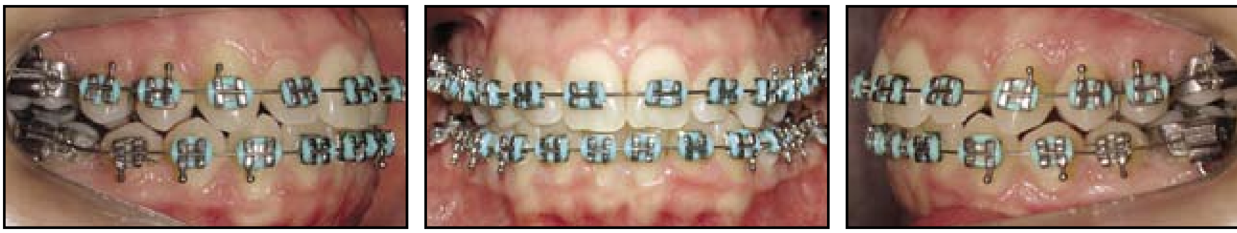
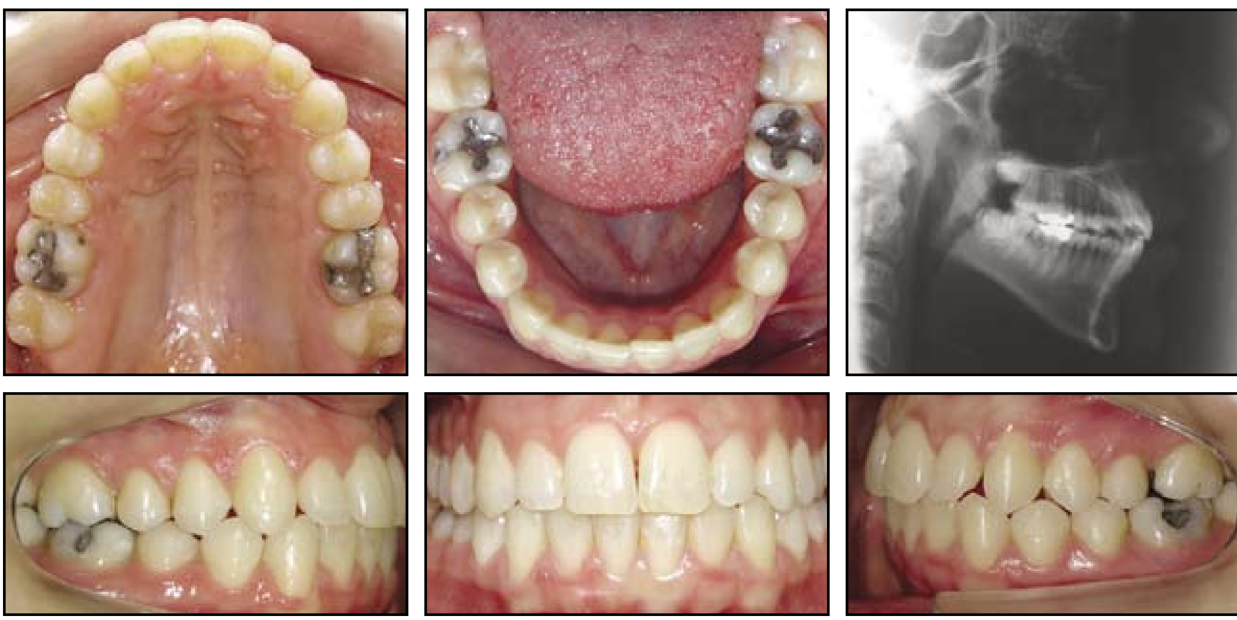


Fig. 11 Patient during orthodontic treatment after maxillary expansion.



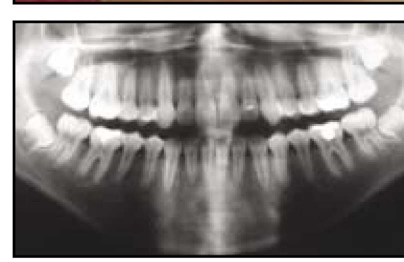


Fig. 12 Patient after seven months of orthodontic treatment following maxillary expansion.

diate magnitude.

In contrast, in the first premolar region, where the expansion was supported by palatal bone, the maxillary width increase at NF was about one-third of the screw activation (1.7mm), and the increases at HP were about two-thirds of the screw activation. At DA and the alveolar crests, the transverse expansion was about half the amount of screw expansion.

The inclination of the maxillary posterior teeth was not significantly altered by the expansion procedure, except that the first molars were tipped buccally (Table 2). Changes in bone plate thickness and in alveolar crest level were also observed only in the first molar region, where the buccal bone plate thickness decreased, the lingual bone plate

TABLE 1
PRE- AND POST-EXPANSION MAXILLARY TRANSVERSE DIMENSIONS (MM)

	Pre-Expansion	Post-Expansion	Change
Maxillary first premolar area			
NF	29.2	30.9	1.7
HP	31.5	35.3	3.8
BAC	35.1	38.2	3.1
DA.E	35.1	38.0	3.0
DA.E′	36.9	40.4	3.5
HP′	8.0	12.8	4.8
PA	23.6	28.7	4.9
LAC	20.1	24.0	3.9
DA.I	23.9	26.7	2.8
DA.I′	20.1	23.4	3.3
Maxillary first molar area			
NF	54.0	54.8	0.8
HP	50.5	52.5	2.0
BAC	44.2	48.4	4.2
DA.E	44.9	51.1	6.2
DA.E′	47.0	52.8	5.8
HP′	17.5	19.8	2.3
PA	25.0	31.0	6.0
LAC	25.0	30.3	5.3
DA.I	31.8	38.0	6.2
DA.I′	26.5	32.7	6.2

TABLE 2
PRE- AND POST-EXPANSION MAXILLARY POSTERIOR TOOTH INCLINATIONS* (°)

	Pre-Expansion	Post-Expansion	Change
First premolar	1.2	–1.5	–2.7
Second premolar	–2.3	–2.9	–0.6
First molar	11.5	15.0	3.5

*Values are means of the right and left sides.

TABLE 3
PRE- AND POST-EXPANSION BUCCAL AND LINGUAL BONE PLATE THICKNESSES* (MM)

	Pre-Expansion	Post-Expansion	Change
Buccal bone plate thickness			
Canine	0.7	0.6	–0.1
First premolar	1.0	0.9	–0.1
Second premolar	1.2	1.4	0.2
First molar, mesial	1.1	0.0	–1.1
First molar, distal	2.0	0.0	–2.0
Lingual bone plate thickness			
Canine	3.0	3.2	0.2
First premolar	2.1	2.1	0.0
Second premolar	1.9	2.2	0.3
First molar	1.2	2.9	1.7

*Values are means of the right and left sides.

TABLE 4
PRE- AND POST-EXPANSION BUCCAL ALVEOLAR CREST LEVELS* (MM)

	Pre-Expansion	Post-Expansion	Change
Canine	11.4	11.7	0.3
First premolar	10.2	10.4	0.2
Second premolar	9.0	8.8	–0.2
First molar, mesial	8.3	11.3	3.0
First molar, center	8.3	9.8	1.5
First molar, distal	8.6	10.0	1.4

*Values are means of the right and left sides.

thickness increased, and buccal dehiscences of about 3mm were observed after expansion (Tables 3,4).

After four months of retention of the maxillary expansion, comprehensive orthodontic treatment was initiated (Fig. 11). Treatment was completed seven months later (Fig. 12).

Discussion

The case reported here illustrates the effectiveness of rapid maxillary expansion using a Hyrax appliance supported by palatal implants. The ratio of basal bone transverse expansion to the amount of screw activation was similar to that of conventional tooth-supported expanders, but there was significantly less buccal tipping of the maxillary posterior teeth. Thus, the procedure reduced the risk of negative periodontal sequelae.

Whereas traditional expansion techniques generally open the maxillary midline suture by the fifth day of screw activation,[2] implant-assisted expansion required 12 days of activation. The need to place the palatal implants distal to the first premolars resulted in a more posterior position of the appliance in the palate than would be seen with conventional expanders. Because the posterior region of the palate is more resistant to separation of the maxillary bone,[2] more force was needed to open the midpalatal suture.

Given the promising results of this new system, future studies should be conducted of rapid maxillary expansion supported exclusively by palatal implants. The implant system presented here can also be used for other purposes, such as surgical distraction and molar distalization.

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