Clinical Article

Unilateral Correction of Space Loss in the Mixed Dentition

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Abstract: *Distalization of maxillary molars is indicated for correction of Class II dental malocclusion and for space gain in cases of space deficiency. The ideal treatment with an intraoral fixed appliance for molar distalization should fulfill the following requirements: patient compliance; acceptable esthetics; comfort; minimum anterior anchor loss (as evidenced by inclination of incisors); bodily movement of the molars to avoid undesirable effects and unstable outcomes; and minimum time required during sessions for placement and activations. The purpose of this paper was to present an alternative treatment for space recovery in the area of the maxillary right second premolar when there has been significant mesial movement of the permanent maxillary right first molar. We used a modified appliance that allows unilateral molar distalization in cases of unilateral tooth/arch size discrepancy using the opposite side as anchor, thus reducing the mesialization of the anterior teeth.* *(Pediatr Dent 2008;30:334-41) Received August 17, 2006 / Last Revision October 17, 2007 / Revision Accepted October 17, 2007*

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Early loss of primary teeth involves several events, such as loss of space within the dental arch, that might lead to ectopic eruption, impacted teeth, Angle Class II or III occlusion, and midline deviation. One of the most severe and common consequences of the premature loss of primary teeth, however, is the excessive mesialization of the permanent first molar, especially when the loss occurs very early. In case of early loss of primary teeth, it is necessary to perform a careful mixed dentition space analysis prior to initiating any space regaining. Several methods have been described for distalization of permanent molars, including extraoral appliances,[1] removable appliances,[2] and different intraoral devices.[3-6] Establishment of the method to be used is directly related to the diagnosis, including the bone maturation stage, growth pattern, and degree of patient commitment to the treatment. Noncompliance of patients with the use of extraoral devices and removable appliances has led many investigators to search for more effective and simple treatment options via intraoral mechanics.

Currently a large variety of alternative orthodontic devices exist for distalization of permanent maxillary molars that do not depend on patient compliance, some of which are fabricated from contemporary materials, such as titanium alloys.[7] The use of titanium alloys in orthodontics has been widespread based on the pioneering study by Andreasen and Brady.[8] The materials have properties, such as shape memory[9] and superelasticity,[10,11] that are advantageous for the application of mild continuous forces, with high efficiency of tooth movement. The pendulum appliance designed by Hilgers has been proven effective, although it may result in undesirable inclination of the permanent maxillary molars.[12,13]

The main indication for Hilgers' pendulum is the correction of a Class II dental malocclusion by distal movement of the permanent maxillary molars. It may be employed during the first stage of treatment for distalization of permanent maxillary molars for correction of Class II malocclusion, and in space recovery in cases of mesial drift of those teeth due to the early loss of primary molars.[14] It may be used for unilateral or bilateral correction in the mixed or permanent dentition. Hilgers' pendulum appliance, however, is contraindicated in cases where skeletal Class II correction is required[14] and in dolichofacial patients due to the increase in vertical dimension by extrusion of molars and premolars. Several modifications have been suggested to the original design of Hilgers' pendulum appliance mainly to improve its accuracy, handling, and control of reactivation force.[13,15,16]

The purpose of this paper is to present an alternative treatment for space recovery in the region of a maxillary right

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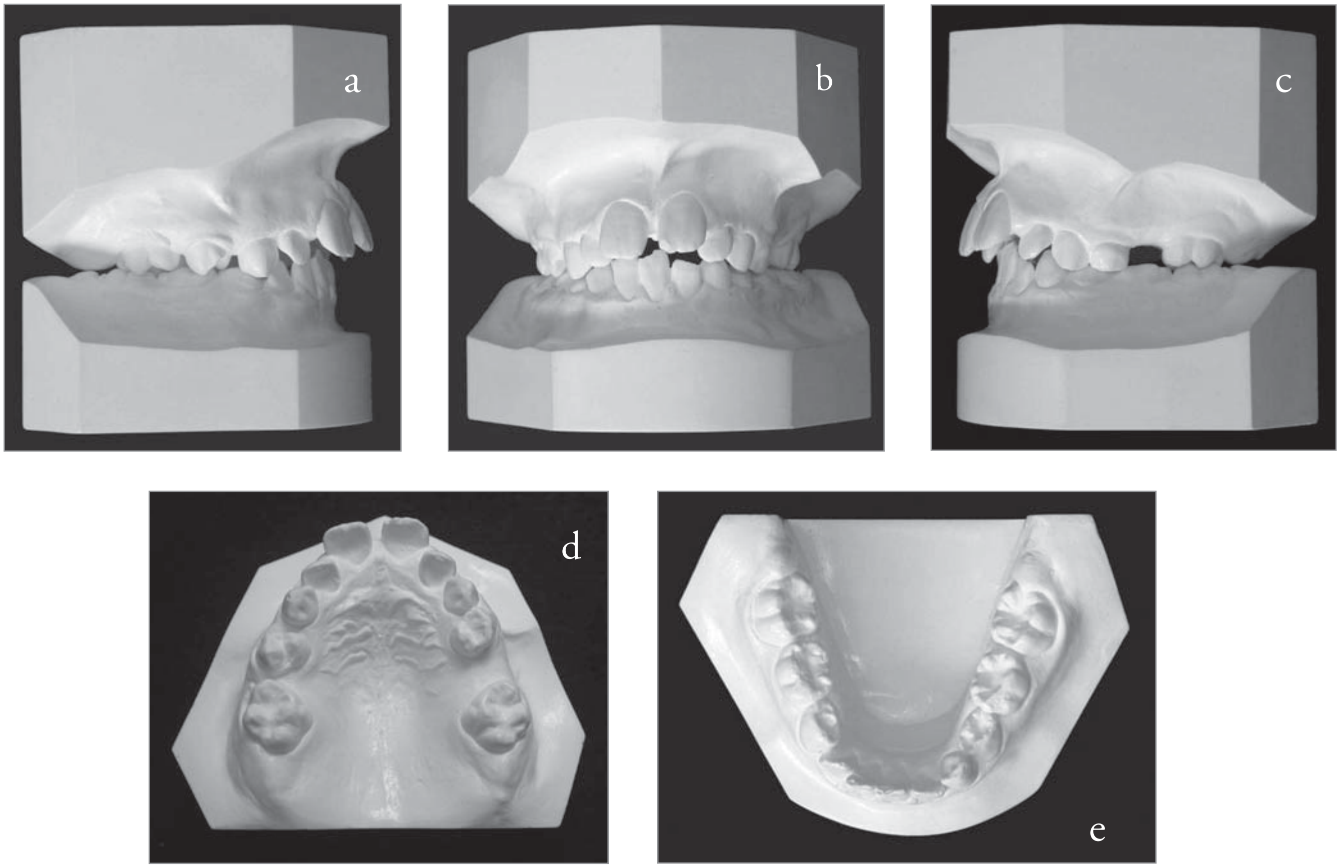

Figure 1(a-e). Pretreatment diagnostic casts.

second premolar where there had been significant mesial drift of the adjacent permanent maxillary right first molar due to a prematurely lost primary tooth. This treatment was not dependent on patient compliance, although patient cooperation was necessary to prevent breakage of the appliance and maintain adequate oral hygiene, thus avoiding the onset of gingival inflammation. This treatment involved an appliance to distalize the molar unilaterally, using the opposite side as anchor, thereby reducing mesialization of the anterior teeth (anchor loss).

Case report

Diagnosis and etiology. At the beginning of treatment, the patient was 8 years 11 months old and had Class II, division 1, right subdivision malocclusion. He was in the mixed dentition stage and was in good general health with a noncontributory medical history. Clinical examination revealed atypical swallowing and speech, due to tongue projection, and absence of temporomandibular joint symptoms. The gingival tissues were healthy, but the large number of restored primary teeth indicated a high caries incidence. Clinical examination and analysis of the diagnostic casts showed parabolic arches with Class II malocclusion at the right side due to migration of the first molar (Figure 1).

The patient, however, had a skeletal Class I profile because of a good maxillomandibular relationship, as confirmed by the cephalometric tracing ANB= 4^o (pattern ranges from 0 to 4^o). The patient presented a slight vertical growth (SNGn=68^o, pattern =67^o; SNGoGn=33^o, pattern =32^o; facial axis=91^o, pattern =87^o) and had a convex facial profile (S-Ls=4 mm, S-Li=3 mm, pattern to S-Ls=0mm/S-Li=0mm, which was confirmed by the cephalometric tracing and the initial extraoral photographs (Figure 2). He showed normal development for his age, yet the pattern of tooth eruption was early, with presence of the maxillary right first premolar erupted in the oral cavity (Figure 1). The early loss of the primary maxillary right first molar secondary to caries and extensive periapical infection accelerated the eruption of the maxillary right first premolar. The primary maxillary right second molar was also prematurely lost, but its permanent successor did not erupt precociously. Therefore, at the region of the maxillary right second premolar, there was no space due to the extensive mesial drift of the permanent maxillary right first molar (Figures 1 and 3). Early loss of the primary maxillary left second molar with palatal rotation of the permanent maxillary left first molar was also observed (Figure 1). There was no space loss on this side of the arch, however, as demonstrated by the mixed dentition analysis. Therefore, the left side underwent

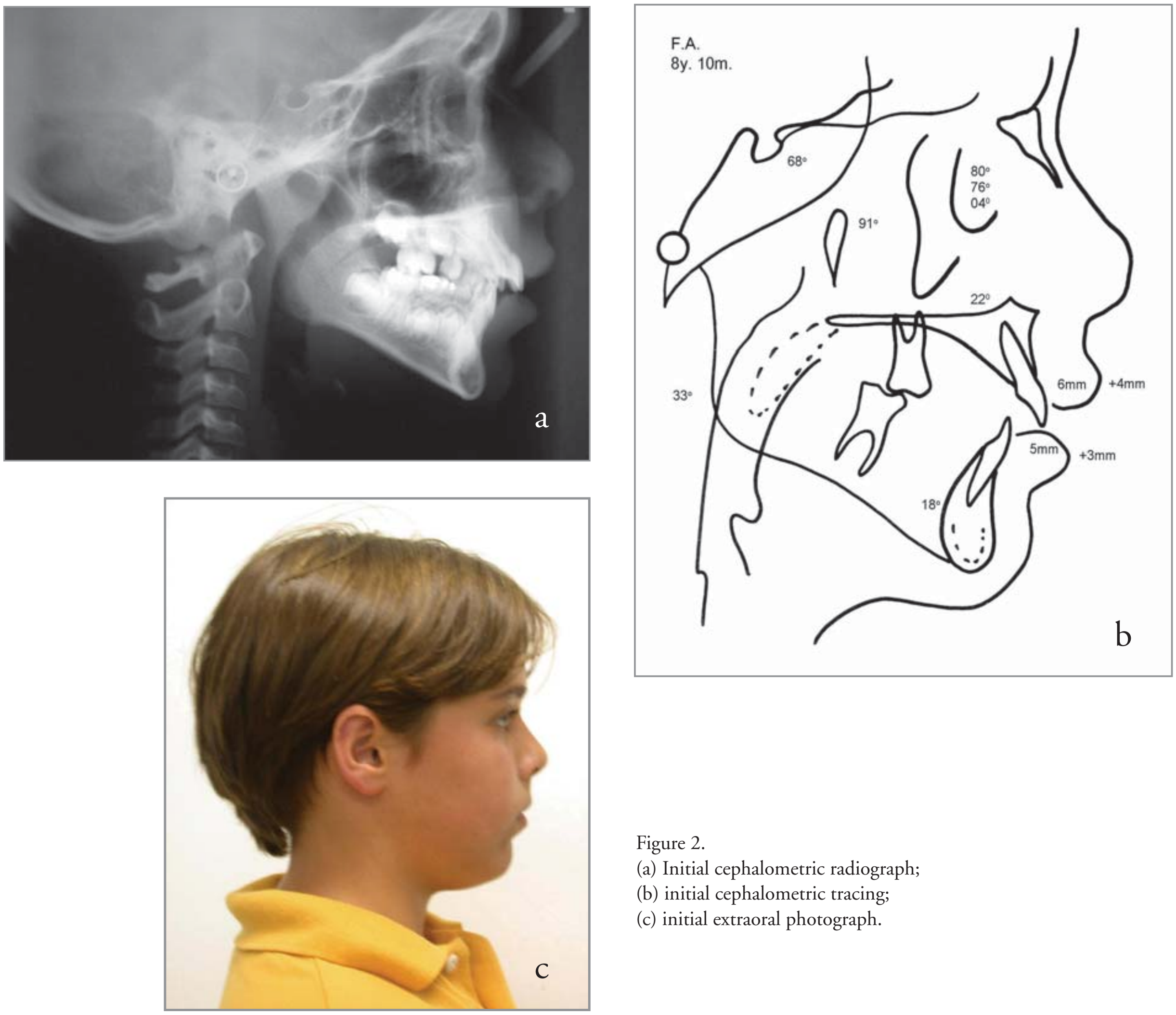

Figure 2.
(a) Initial cephalometric radiograph;
(b) initial cephalometric tracing;
(c) initial extraoral photograph.

space maintenance and subsequent correction of the palatal rotation of the permanent first molar with fixed orthodontic appliance therapy. Mixed dentition analysis using Moyers' method showed a discrepancy of +2 mm in the mandibular arch and -6 mm in the maxillary arch, with -5 mm on the right side and -1 mm on the left side.

The panoramic radiograph showed that the dentition was developing in accordance with the patient's chronological age, but only one third of the roots were formed on the maxillary right second premolar; the two permanent maxillary second molars' crowns were completely formed (Figure 3).

Treatment goals. The patient's immediate problem was the lack of space for eruption of the maxillary right second premolar, due to early loss of the primary maxillary right second molar and consequent excessive mesialization of the permanent maxillary right first molar, which was confirmed by analysis of the diagnostic cast and radiographs (Figures 1 and 3). Therefore, the following steps were established:

1. elimination of the atypical swallowing habit and redefinition of the perioral muscular function;
2. space recovery for eruption of the maxillary right second premolar; and
3. alignment, leveling, and correction of the occlusion with corrective orthodontics in the permanent dentition.

Treatment progress. To eliminate the patient's tongue-thrusting habit and improve lip tonicity, myofunctional treatment was performed by a speech therapist at the same time the space-regaining treatment was performed.

Due to the patient's age and lack of space for eruption of the maxillary right second premolar, a modified space recovery appliance was placed (Figure 4) to recover the large space lost with minimum anchor loss and extrusion on this side. In such cases, the space should be regained before the eruption of the permanent second molar because erupted teeth are in a more

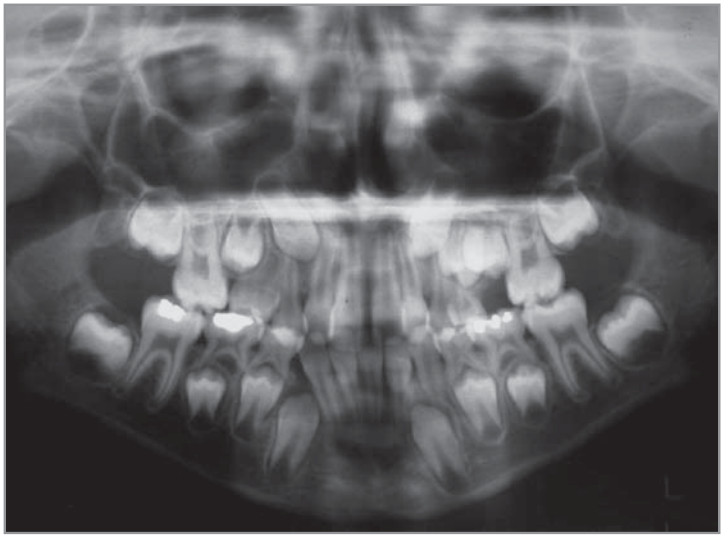

Figure 3. Pretreatment panoramic radiograph.

advanced developmental stage than nonerupted teeth. This means that the distalization of the permanent first molar after eruption of the second molar is more difficult. During this period, 4 periapical radiographs were taken monthly to control the distalization of the permanent first molar and prevent the impaction of the permanent second molar.

Lastly, a fixed appliance was placed after all permanent teeth erupted to conclude the treatment and re-establish the patient's normal occlusion.

Appliance fabrication and use. The appliance used in this case was based on Hilgers' pendulum appliance.[12] The titanium molybdenum alloy (TMA) coil (Ormco Corporation, Glendora, Calif), however, was placed only at one side while the opposite side served as an anchor, similar to the Haas appliance. This appliance consisted of a large acrylic button adapted to the palate that was used as anchor, thereby reducing mesialization of the anterior teeth and extrusion of the permanent first molar (Figure 4a). Auxiliary stainless steel wires and the TMA coil were adapted to this button. The active TMA coil was fabricated with a 0.032-inch wire, with a loop in the center and 2 arms. One arm turned toward the distal surface for insertion in the palatal tube of the molar band, and the other arm was used for retention incorporated to the acrylic (Figure 4a). The auxiliary wires were fabricated with 0.028-inch stainless steel wires and bonded to the occlusal surface of the first premolar (Figure 4a). Another auxiliary 0.036-inch stainless steel wire was also fabricated with adaptation to the palatal surfaces of the permanent maxillary left first molar and primary maxillary left molar. This auxiliary wire was soldered to the band of the permanent maxillary left first molar, used as anchor (Figure 4a).

Activation of the TMA coil may be performed intraorally. The amount of force is better controlled, however, when performed on a stone cast before placement into the patient's mouth. Therefore, the TMA coil was activated at 45º in a posterior direction before intraoral placement (Figure 4b). Placement of the appliance was initiated by cementation of the band with the palatal tube on the tooth to be distalized (the permanent maxillary right first molar). Then, the band connected to the appliance (the permanent maxillary left first molar) with the activated coil was adapted and cemented. The end of the TMA coil, however, was initially adapted to the palatal tube via pliers before cementing the appliance. This clinical procedure provided better adaptation of the appliance rather than the introduction of the TMA coil only after its cementation, as recommended by some authors. In addition, this technique prevents injuries to the palate's soft tissues

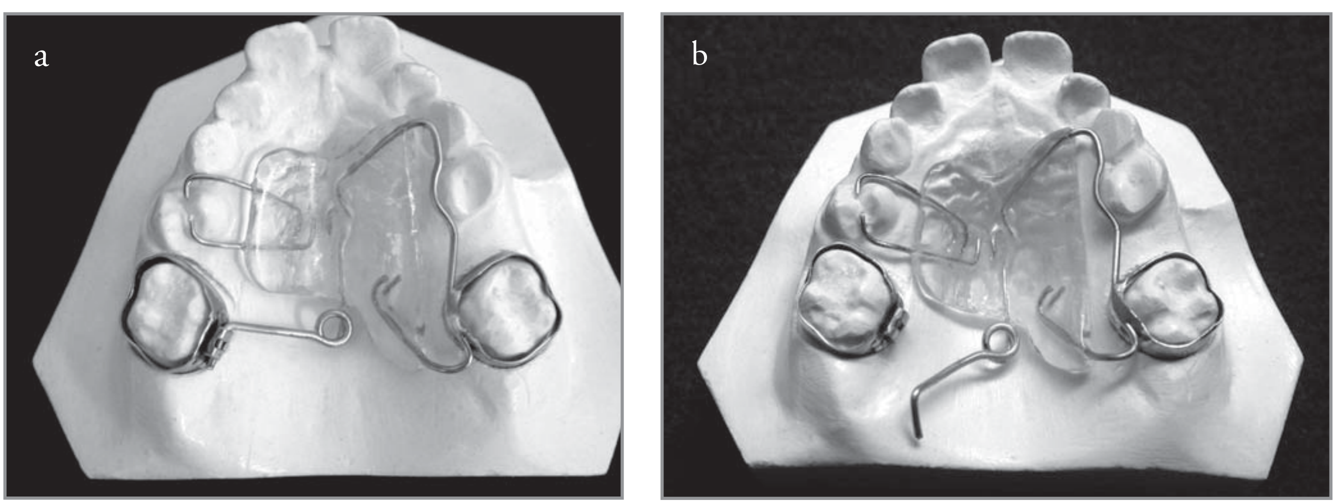

Figure 4. (a) Modified appliance for space recovery. Shown is an active TMA coil with a loop in the center and 2 arms: one is turned toward the distal surface for insertion into the molar band's palatal tube, and the other is used for retention incorporated into the acrylic. Also shown are 2 auxiliary wires: one is adapted to the first premolar's occlusal surface, and the other is soldered to the band of the left first molar. (b) titanium molybdenum alloy (TMA) coil activated at 45º in a posterior direction before placement.

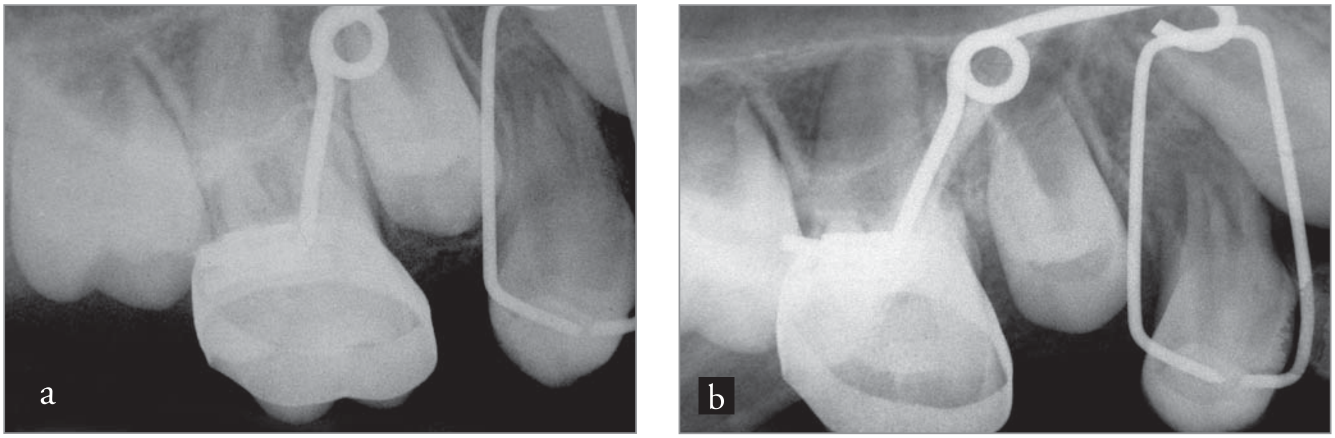

Figure 5. Initial and final periapical radiographs.

while trying to introduce the TMA coil with orthodontic or Mathieu pliers after cementing the appliance. Thereafter, the auxiliary wires were bonded to the maxillary right first premolar's occlusal surface with a light cured resin.

Monthly radiographs were made to follow the treatment (Figure 5). This procedure was necessary not only to follow-up the maxillary right second premolar's eruption but to also prevent the impaction of the permanent maxillary right second molar against the root of the permanent maxillary right first molar because these teeth were too close to each other. Patients should be instructed on the maintenance of this appliance, as they are after placement of fixed expanders.

Results

The patient was examined every 3 weeks to check the pressure of the coils and the appliance's stability. The distal pendular movement began to appear after nearly 5 weeks, although the space was effectively opened at the 12th week (Figure 5). In adults, the responses are slower, due to the presence of erupted second molars. The appliance used in this case yielded 5 mm of distalization within 4 months. No reactivation was performed during this period. Nevertheless, if required, the coil may be removed from the palatal tube and reactivated by pulling it to the midline and reinserting it into the palatal tube. Retention—consisting of a transpalatal bar fabricated from 0.036-inch wire— was placed at the same session, during which the TMA coilwas removed. Retention was maintained until complete eruption of the second premolars because while the inclination of the first molar provides space recovery, the distalization is not totally stable.

The 5-mm distalization of the permanent maxillary right first molar resulted in a Class I molar relationship on this side. Final alignment of the permanent teeth was performed with the placement of fixed orthodontic appliances (maxillary and mandibular arches) for an additional 4 months after space recovery and total eruption of the permanent teeth. This enabled an adequate occlusion (Figure 6). In the transverse direction, a posterior crossbite tends to develop in a tooth undergoing distalization. To prevent this, an expanding screw may be inserted in the midline and activated, if necessary. In this case, there was no development of a posterior crossbite during the distalization procedure. This is probably because the TMA coil inserted into the lingual sheath on the permanent maxillary right first molar was just one thickness (0.028-inch), not 2 thicknesses (0.056-inch), allowing buccal movement as the tooth was distalized.

The control panoramic (Figure 7) and cephalometric radiographs taken after eruption of all permanent teeth (11 years 4 months) showed a normal pattern. There was no increase in the vertical dimension of the face, but the facial profile improved (Figure 8). This was probably due to facial growth, since no mechanics were used to change the profile.

Treatment was completed about 8 months. However, the interval between the pre- and the post-treatment radiographs was longer than 8 months because the patient delayed the final documentation appointment.

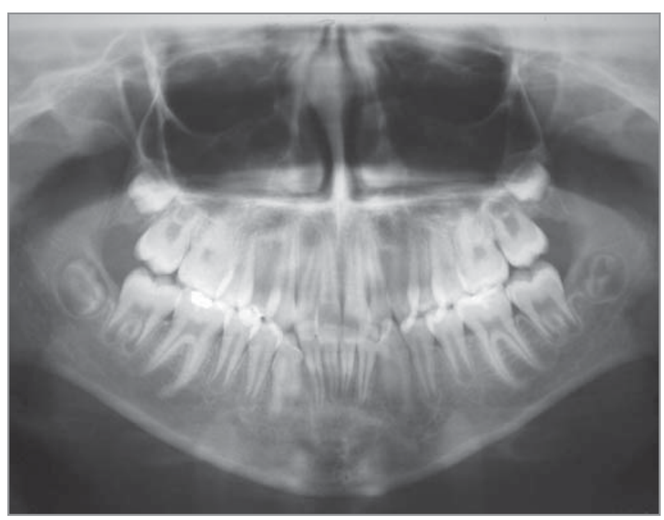

Figure 7. Post-treatment panoramic radiograph (taken at 11 years 4 months of age).

Figure 6(a-e). Post-treatment intraoral photographs (taken at 11 years 4 months of age).

Discussion

The primary dentition serves many functions that are fundamental to a child's continued well-being and development. An intact primary arch plays an important role in speech, mastication, esthetics, prevention of bad habits, and guidance of the eruption of permanent teeth. Each of these functions may be influenced by premature loss of primary teeth that might lead to undesirable tooth movements and, therefore, reduce the arch space available for the succeeding permanent teeth.[17] The resulting lack of arch space can produce or exacerbate crowded, rotated, and impacted permanent teeth.[18]

Although a consensus has not yet been reached, most studies have reported that early loss of primary teeth causes interdental spaces to grow smaller.[19, 20-24] Most of this space loss seems to occur within the first 6 months to 1 year following tooth loss due to the mesial drift of the permanent first molar and, to a lesser degree, distal drift of the teeth located mesially to the extraction site.[21] The amount of space loss depends specifically on the lost tooth.[20,25,26] Premature loss of a primary maxillary and mandibular second molars generally causes more severe space loss than the loss of a primary first molar, canine, or incisor.[21,25,27,28] Tooth loss at an early age also is associated with more severe space loss, especially if the loss occurs before the eruption of the permanent first molars.[20,21,23,25,26,29] Thus, the premature loss of primary teeth has been shown to increase the prevalence of malocclusion in the permanent dentition.[27,28,30-32]

The occurrence of malocclusion following premature tooth loss depends on both the tooth type and the patient's dental age.[18] Loss of the primary second molars is more likely to lead to malocclusion than the loss of any other primary teeth,[27,28] and malocclusion is more likely if primary teeth are lost at an earlier age.[32] It has been suggested that the premature loss of primary teeth has a definite, although limited, influence on the prevalence of malocclusion in the permanent dentition.[18]

Some dental effects secondary to the use of Hilgers' appliance have been demonstrated, such as reports that the primary molars or premolars used as anchor undergo mild mesial movement[13,15,33,34] and mild extrusion.[13,15,34] The movement of the dentition anterior to the permanent maxillary molars could be termed "anchor loss." Little, if any, forward movement of the anterior teeth was observed, however, in our patient, who wore only this appliance (Figure 8b). It is probably due to the type of anchor we used (ie, the whole left hemiarch was used as an anchor similar to the Haas appliance; Figure 4a). Another negative effect of Hilgers' appliance is that it may cause palatal inclination of the permanent maxillary molar when it is being distalized, thus resulting in posterior crossbite.

In cases such as this, the insertion of an expanding screw in the pendulum appliance reduces these transverse effects, mainly when both first molars are distalized at the same time. Nevertheless, this undesirable effect was not observed with use of the modified pendulum appliance presented in this case report, probably due to the use of an 0.028-inch stainless steel wire that was introduced into the palatal tube of the permanent maxillary right first molar band.. This allowed additional buccal movement of this tooth during distalization. In addition, the degree of activation of this coil was less than that recommended by Hilgers. The coil was activated at 45º and not 90º, as recommended by some authors. Although force is delivered in a Class I direction in this appliance, it is contraindicated in cases of extreme vertical growth patterns

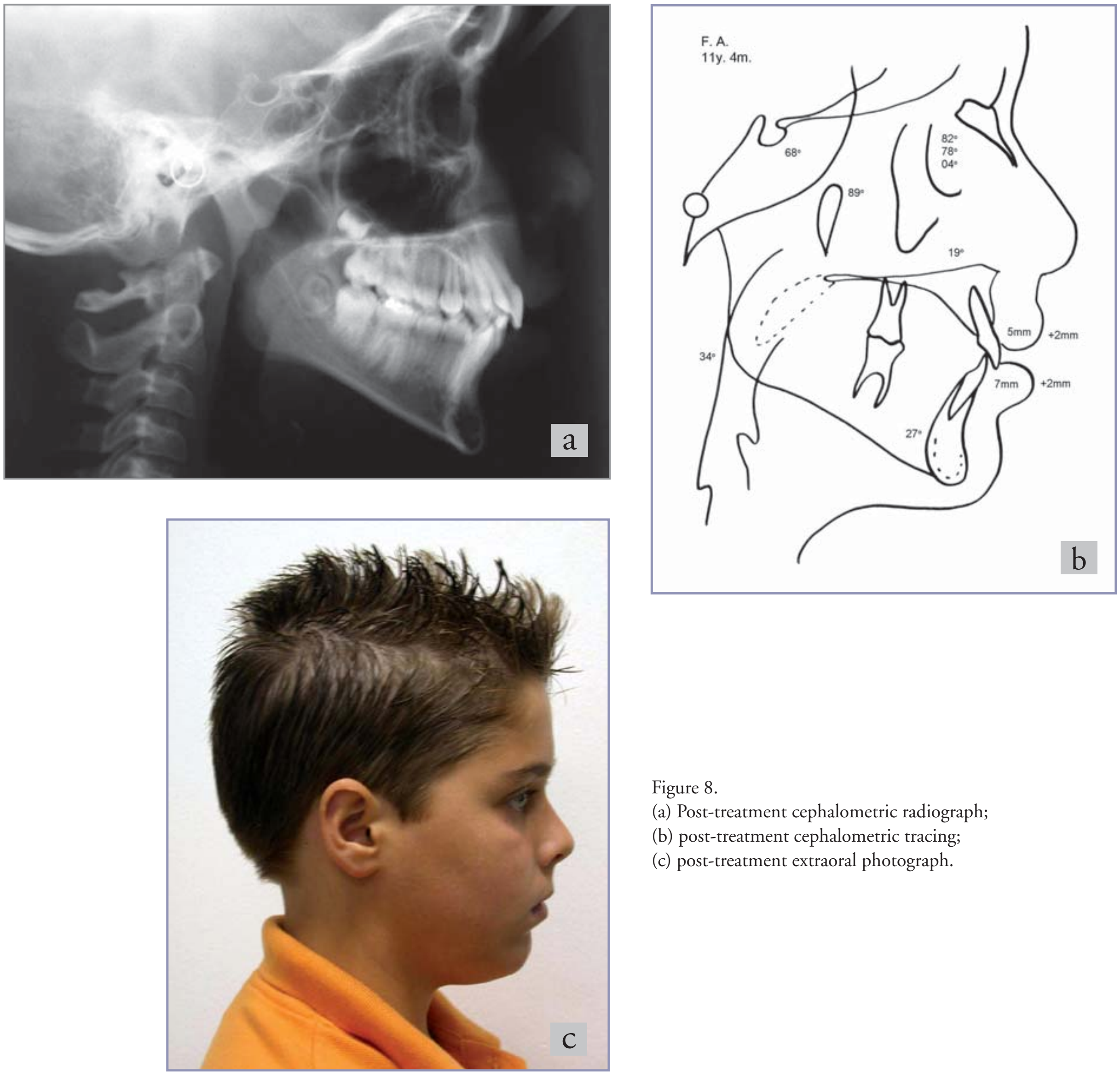

Figure 8.
(a) Post-treatment cephalometric radiograph;
(b) post-treatment cephalometric tracing;
(c) post-treatment extraoral photograph.

because extrusion of the molars is not restricted. Due to the anchor obtained in the left side, dental extrusion was not observed in our patient, which is demonstrated by the final cephalometric values (Figure 8b).

Retention should be placed immediately after removal of the appliance, preferably in the same session. The Nance button or transpalatal bar is the most commonly employed.[3,5,35] In our patient, a transpalatal bar was employed.

The appliance described in this paper successfully produced distal movement of a permanent maxillary molar to a Class I relationship in the mixed dentition. It is a predictable, rapid method for correction of space loss (unilateral Class II relationship) without the need for much patient cooperation. This method was well tolerated by the periodontium as observed during periodic follow-ups and radiographic evaluations. Space recovery should be completed as soon as possible to avoid mesial movement of the permanent maxillary right second molar, which makes the distalization procedure harder.

The potential disadvantages of this device include soft tissue impingement, plaque accumulation, and appliance breakage, which justifies the need for periodic follow-up. Its possible benefits include the reduction of crowding, ectopic eruption, tooth impaction, and poor molar relationships, as well as providing a cost savings by reducing the need for future corrective orthodontic treatment.

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