Case Report

Unilateral Horizontally Impacted Maxillary Canine and First Premolar Treated with a Double Archwire Technique

Chien-Lun Peng[a]; Yu-Yu Su[b]; Sheng-Yang Lee[c]

Abstract: A patient with a unilateral horizontally impacted upper left canine and first premolar was treated orthodontically. The use of a double archwire technique achieved the desired treatment goals. We discuss the problems associated with impacted maxillary canines and first premolars and the biomechanical interventions used for this patient. (*Angle Orthod* 2006;76: 502–509.)

Key Words: Impacted canine; Impacted premolar; Horizontal impaction; Double archwire

INTRODUCTION

Maxillary canines have the longest period of development, the deepest area of development, and the most difficult eruption path of all the teeth.[1] Other than the third molars, the maxillary canines are the most likely to remain unerupted or impacted. They are also the teeth that most commonly require surgical exposure and orthodontic guidance during eruption.[2]

The maxillary permanent canine is generally considered important by virtue of its place in the scheme of functional occlusion, its contribution to the appearance of the patient, its size and root length, and its role in establishing archform. For all these reasons, orthodontists have accepted the challenge of the impacted canine with enthusiasm and have recommended many methods and ideas to bring about its speedy and effective resolution.[3–6]

Assessing the position and path of eruption of an unerupted maxillary canine is important for developing a comprehensive treatment plan. The position can be deduced from a true lateral skull or a standard occlusal film and a panoramic radiograph. Orton et al[7] reported a principle for treating an unerupted canine by assessing the vertical axial eruptive path (VAEP). They suggested that an ideal VAEP of an unerupted upper canine is about 10° of labial tipping relative to the Frankfurt Horizontal plane. They further suggested that forward tipping of 15° to 25° requires treatment, tipping of 25° to 45° is progressively more difficult, and labial tipping of over 45° is generally orthodontically untreatable.

Stivaros and Mandall[8] and their colleagues studied the factors affecting the management of impacted upper permanent canines using a retrospective, cross-sectional design. They found that decisions to expose or remove an impacted upper permanent canine, on the basis of radiographic information, seem to be primarily guided by the labiopalatal crown position and angulation to the midline. They also reported that as the canine angulation to the midline increased (meaning the canine lies more horizontally), the canine was more likely to be removed by the orthodontist.

Although these previous articles mentioned and discussed various principles for treating impacted canines, the treatment of a horizontally impacted canine and premolar simultaneously has not yet been reported. A case is described in which a horizontally impacted maxillary canine and first premolar in the left maxilla of a female patient were treated simultaneously with only a maxillary appliance.

CASE REPORT

History

A 15-year-old Taiwanese girl was referred by her dentist because of retained deciduous molars in the left maxilla. The girl was in good health, and the dental

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FIGURE 1. (A–D) Pretreatment facial and intraoral facial photographs.

and medical history was unremarkable with only the usual childhood maladies.

Diagnosis

The extraoral clinical examination disclosed a symmetrical face with balanced vertical thirds. The profile was straight for Asian people (Figure 1). The intraoral examination revealed that the dental midlines were concordant with each other and with the face and no mandibular shift was detected on closure. Except for some lower incisor crowding and rotation of the second premolars, the overall occlusion was fair with acceptable overjet and overbite. The right canine and molar relationship was Class I, and the upper left deciduous canine and the first molar were still in place.

A radiographic examination revealed that the maxillary left canine was in a horizontal position with its crown tip near the apex of the lateral incisor and its root positioned above the root apices of the posterior teeth (Figure 2). The maxillary left first premolar was located horizontally under the left canine with its crown above the root tip of the retained maxillary left deciduous first molar and its root superimposed over the roots of the second premolar and first molar (Figure 3). A vertical tube shift technique with periapical radiographs confirmed that the root of the impacted first premolar was palatal to the second premolar and first molar.

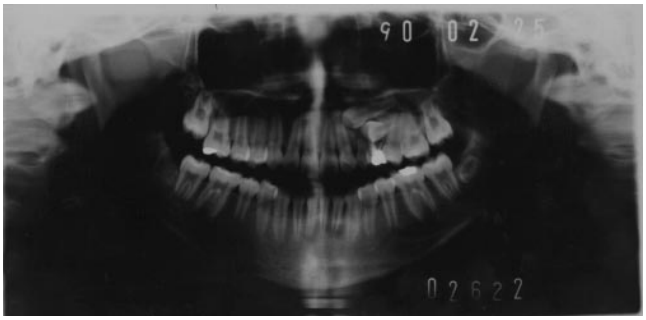

FIGURE 2. Pretreatment panoramic radiograph.

The VAEP according to the study of Orton et al[7] was calculated at 68° (>45°) (Figure 4A); and the canine angulation to the midline[8] was 71° (grade 3 ≥ 31°) (Figure 4B). Both values suggested a very difficult problem, which might not be orthodontically treatable.

After careful evaluation of this case, we decided to treat these two impacted teeth orthodontically. Full mouth orthodontic treatment was suggested. However, because of budget limitations, the patient's parents asked for local treatment of the impacted teeth. It was

FIGURE 3. Pretreatment periapical radiograph of the left upper canine-premolar region. Note that the root axes of both impacted teeth were quite parallel to the occlusal plane.

our goal to treat this case with a nonextraction orthodontic approach using only an upper jaw appliance, while doing our best to correct the impacted teeth, maintain the profile and reach as good a final occlusion as possible.

Treatment

The objectives of orthodontic treatment for this patient were to bring the impacted maxillary left canine and first premolar into the dental arch, level and align the arches, maintain the normal overjet and overbite, and achieve a bilateral Class I canine and molar occlusion. The orthodontic treatment was performed using maxillary 0.018 × 0.025–inch preadjusted multibracket appliances. The initial alignment and leveling was achieved with a wire sequence of 0.0175-inch multistranded wire and 0.016-inch nickel-titanium archwire. A canine-premolar bypass archwire (0.016-inch stainless steel) with an open coil was placed to hold and, if necessary, to create adequate space for the maxillary left canine and first premolar and to consolidate the entire maxillary arch into a composite anchor unit (Figure 5).

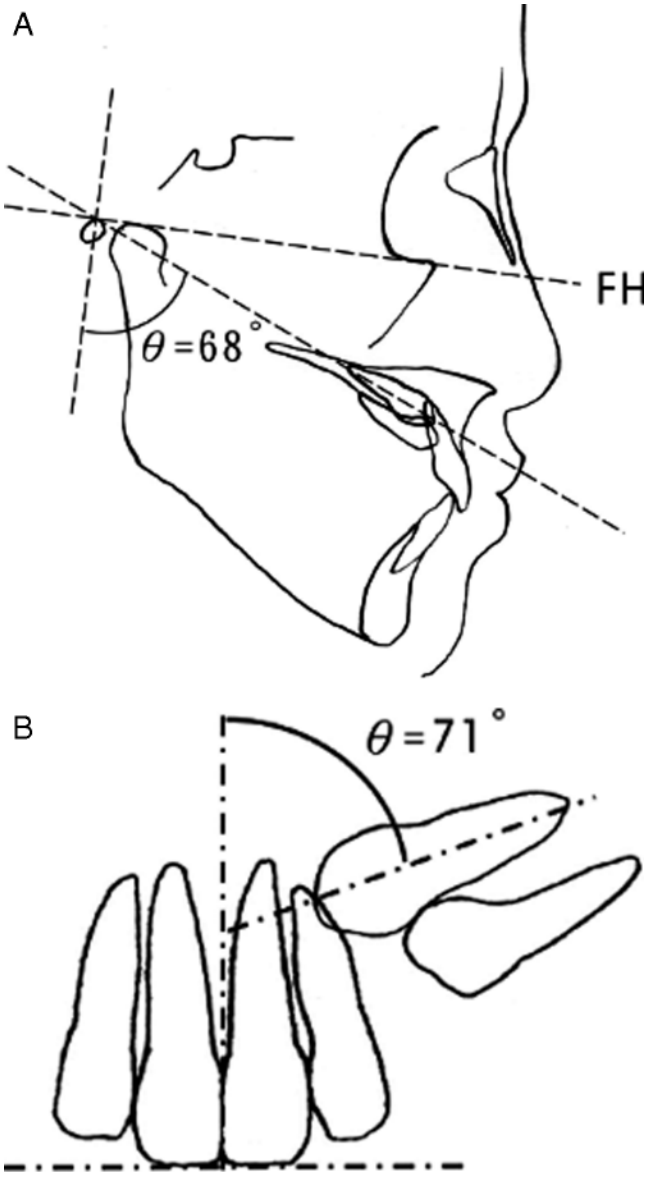

FIGURE 4. Schematic illustration of the diagnostic measurement of the canine axis. (A) Vertical axial eruptive path, according to Orton et al.[7] (B) Canine angulation to the midline, according to Stivaros and Mandall.[8]

To bring the maxillary left canine and first premolar into the dental arch, these two teeth were moved one tooth at a time. First, we had the retained maxillary deciduous canine and molar removed by the oral surgeon. At the same time, a vertical repositioned, full-thickness mucoperiosteal flap was elevated, and the crown of the first premolar was exposed.

A bracket was bonded on the first premolar soon after the crown exposure. In addition, an auxiliary archwire (0.016-inch nickel-titanium) was laid on the main archwire and fixed on the brackets with plastic ligatures. Both distal ends of the auxiliary archwire

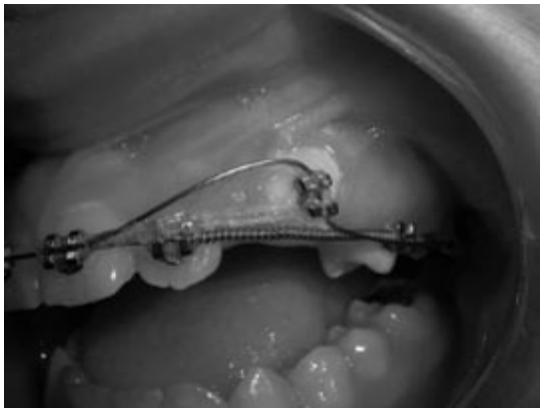

FIGURE 5. A left buccal view during treatment shows a 0.016-inch stainless steel main wire with an opened-coil spring to hold the space for the canine and first premolar. An auxiliary nickel-titanium archwire (0.016-inch) is fixed on the main wire with elastic ligatures and engages on the upper left first premolar. A power chain is attached on upper left central incisor extending to the impacted first premolar.

were secured in the auxiliary tube of the molar bands. The left portion of the auxiliary wire was not fixed on the left lateral incisor so as to provide a more flexible section of wire to align and level the high-impacted first premolar. Because the nickel-titanium wire was engaged into the bracket slot of the first premolar, a counterclockwise moment for correction of the root angulation was provided (Figures 5 and 6A). To prevent accidental contact with the canine while moving the root of the first premolar into an upright position, mesial and downward traction was applied to the first premolar, using an elastic chain ligated from the left central incisor to the first premolar so as to move the root of first premolar away from the root of the canine during correction of the root angulation.

Once the upper first premolar had moved mesially and downward, distal traction with an elastic chain was extended from the left first molar to the left first premolar to provide a force for distal movement of the first premolar (Figure 6B). The auxiliary archwire was disengaged on the first premolar during this time to prevent further mesial movement of the root and contact with the canine's root.

Because the left first premolar reached its position in the upper arch, the horizontally impacted canine

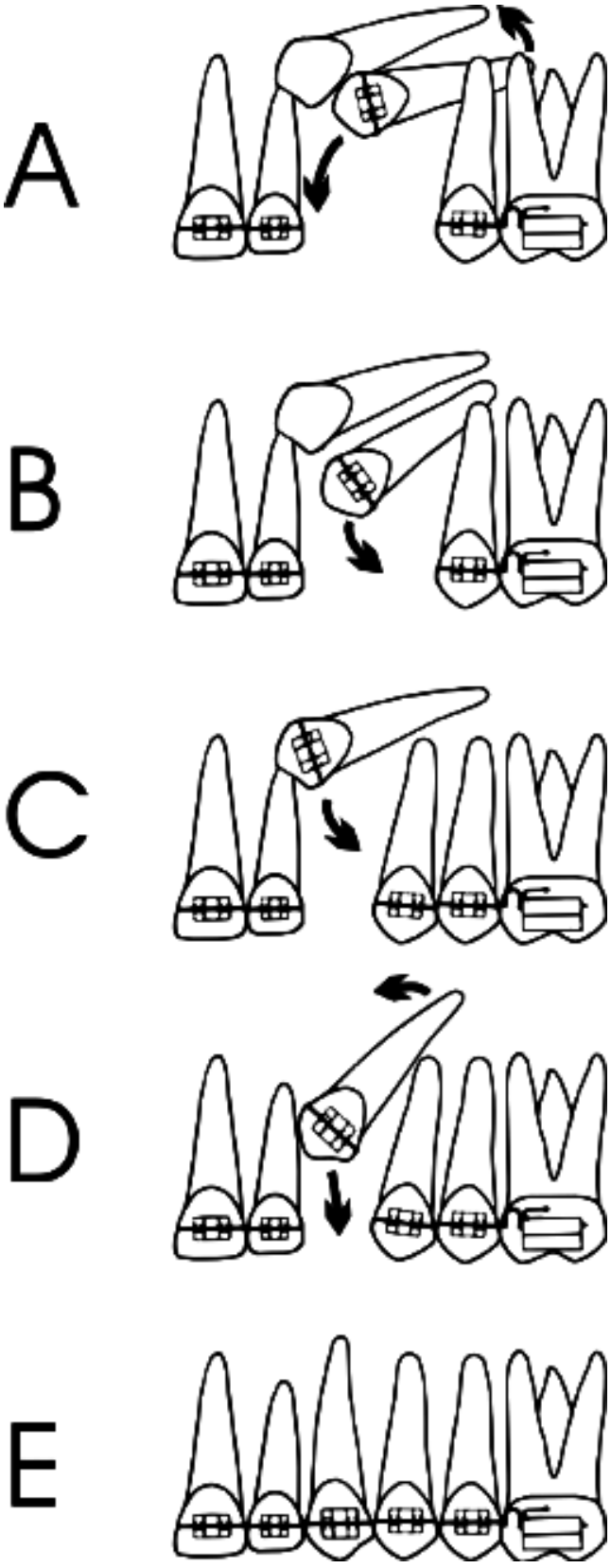

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FIGURE 6. (A–E) Schematic illustration of the treatment strategy in five steps. Step A: the first premolar was moved mesially and downwards, whereas the root tip moves upwards. Step B: the first premolar is moved distally and downwards. Step C: the first premolar in position. The canine is bonded and moved distally and downwards. Step D: the canine is moved downwards and the root continues to an upright position. Step E: the canine in position.

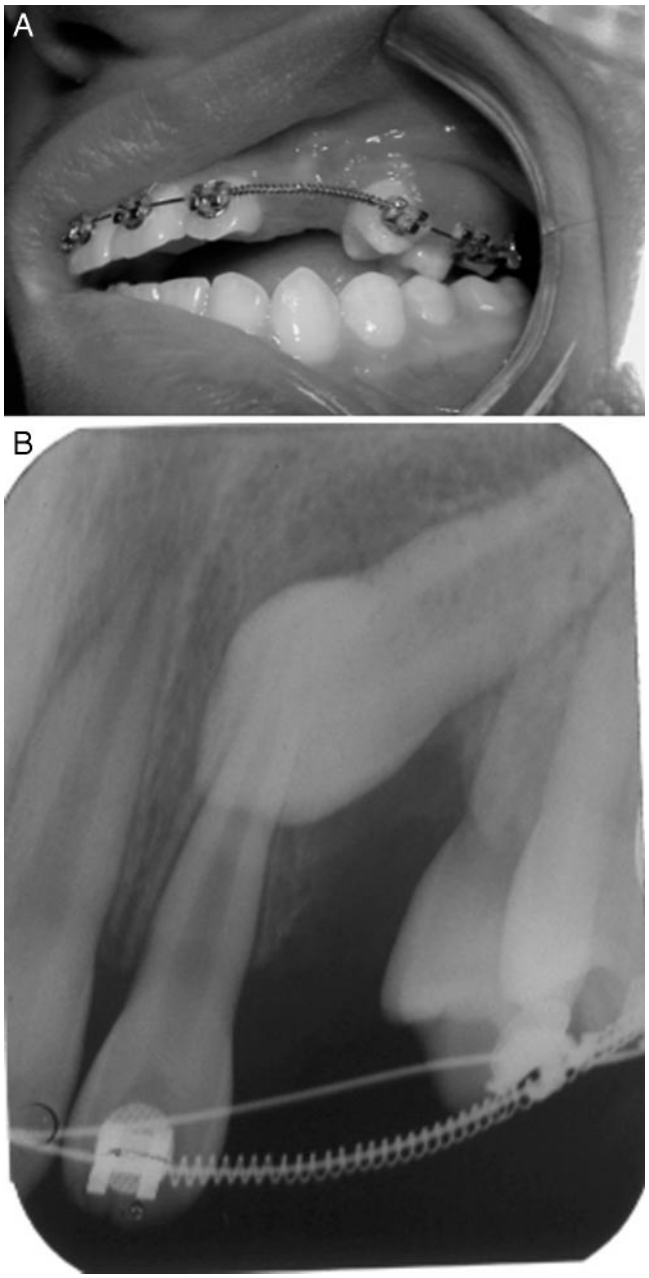

FIGURE 7. Buccal view (A) and periapical radiograph (B) after first premolar correction.

was surgically exposed and bracketed (Figures 6C and 7A,B). Because the crown tip of the left canine was located to the mesial and buccal of the lateral incisor's root apex, a downward and backward force was applied on the bracket of the left canine, using an elastic chain extending from the first premolar to the canine without an auxiliary archwire (Figure 6C). This was to pull the crown tip of the canine away from the apex of the lateral incisor's root, which also served to correct the angulation of the canine.

After the canine had reached a lower and more distal position, the nickel-titanium auxiliary archwire was engaged again to provide an additional moment to upright the root of the canine and thus avoid contact with the root tip of first premolar during the downward movement of the canine (Figure 6D). Finally, the canine was aligned in the arch (Figure 6E).

FIGURE 8. Periapical radiograph shows the roots of first premolar and canine well aligned.

Detailing bends were made on the 0.016-inch stainless steel main archwire to adjust the alignment of the teeth. A periapical radiograph showed satisfactory progress in the eruption of both impacted teeth (Figure 8). The final 0.016 $\times$ 0.022–inch stainless steel archwire was placed to adjust the root torque. An excessive buccal root torque for overcorrection was applied on the upper left canine to prevent relapse. Because an acceptable occlusion with adequate root dispersion had been achieved, the fixed appliance was removed (Figure 9). The total treatment time for this patient was 20 months. Retention was established with a maxillary removable retainer.

The posttreatment panoramic view showed that the roots of the teeth in the upper arch were well angulated and aligned (Figure 10). No apical root resorption was evident on the radiograph. The midline as well as the overjet and overbite had been maintained during the treatment. Periodontal health was not compromised. The patient has been in retention for more than 24 months, and the upper dentition has been very well maintained during this time. The 17-months posttreatment follow-up shows the result without any obvious relapse (Figure 11). The midline, overjet, and overbite are still in good position. No tooth morbidity is evident. The gums are healthy, and the gingival attachment in the left upper canine and first premolar region is intact. The patient is satisfied with the treatment results.

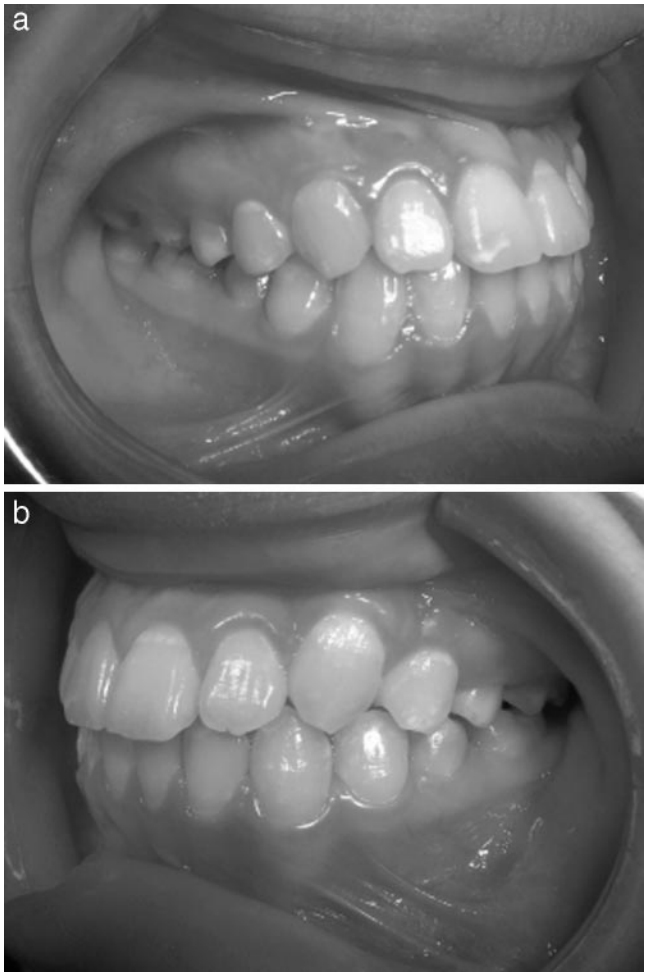

FIGURE 9. (A and B) Posttreatment intraoral photographs.

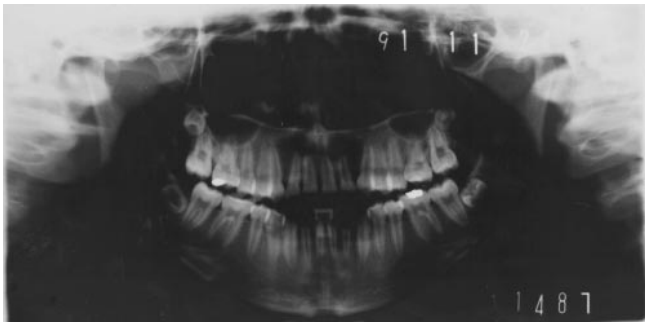

FIGURE 10. Posttreatment panoramic radiograph.

DISCUSSION

The final occlusion of this case would have been better if the patient had accepted full mouth orthodontic treatment. However, it is not possible for every patient to accept full treatment without consideration of the cost. A compromise to reduce the treatment fee is sometimes necessary in Taiwan. An alternative treatment for this young female patient would have been extraction of the two impacted teeth and rehabilitation with prosthesis, such as a bridge, removable denture, or implants. The advantages of treating without extracting the canine were both functional and esthetic. A normal complement of anterior teeth would be the most attractive and would be most likely to achieve functional ideals (elimination of nonworking contacts, and achievement of ideal overjet and overbite). The disadvantages of attempting to keep both the maxillary canine and the first premolar included prolonged treatment time and the possibility of failure. The impacted teeth could have become ankylosed, lost vitality, or succumbed to root resorption, or all.[3] Fortunately, these problems did not occur on this patient.

From a biomechanical perspective, if sufficient space for the canine exists or has been created, it is desirable to deliver a light, point force in the occlusal direction. When elastic chains or threads are used to deliver the single erupting force to the canine from a rigid-base archwire, the forces must be kept light because of the high load deflection rate and the rapid decay of the force delivered by the elastics. Including many teeth also helps distribute the unwanted intrusive side effects among a larger cumulative root surface area and thus to minimize localized deleterious effects. Also, to apply a more rigid and larger size main archwire plus an open-coil spring helps hold the canine space and to prevent intrusion of the adjacent teeth during canine extrusion.

Nevertheless, the forward tipping of the first premolar and backward tipping of the lateral incisor has often been observed simultaneously with their intrusion, creating an open bite in the canine region. Therefore, vertical elastics are often used concurrently to avoid the bite opening in the canine region. This method requires good patient cooperation. However, it is not possible to apply vertical elastics if the patient is being treated without a fixed appliance in the mandible. A method has been reported to solve this problem using a well-clasped lower removable appliance to move the upper impacted canine with light elastics.[7]

This reported case shows the treatment of a high-impacted canine and first premolar lying horizontally in the left maxilla of the patient. The challenges were how to hold the midline and prevent intrusion of adjacent teeth and how to preserve the overjet and overbite with only a maxillary appliance.

Considering the patient's overall condition, it was decided to move the two impacted teeth one at a time to minimize the intrusive effect. We removed the premolar first because there was insufficient room for the canine to extrude. The canine would soon come into contact with the underlying first premolar, unless we used the crown of the canine as a center of rotation and moved the root of the canine to an upright position

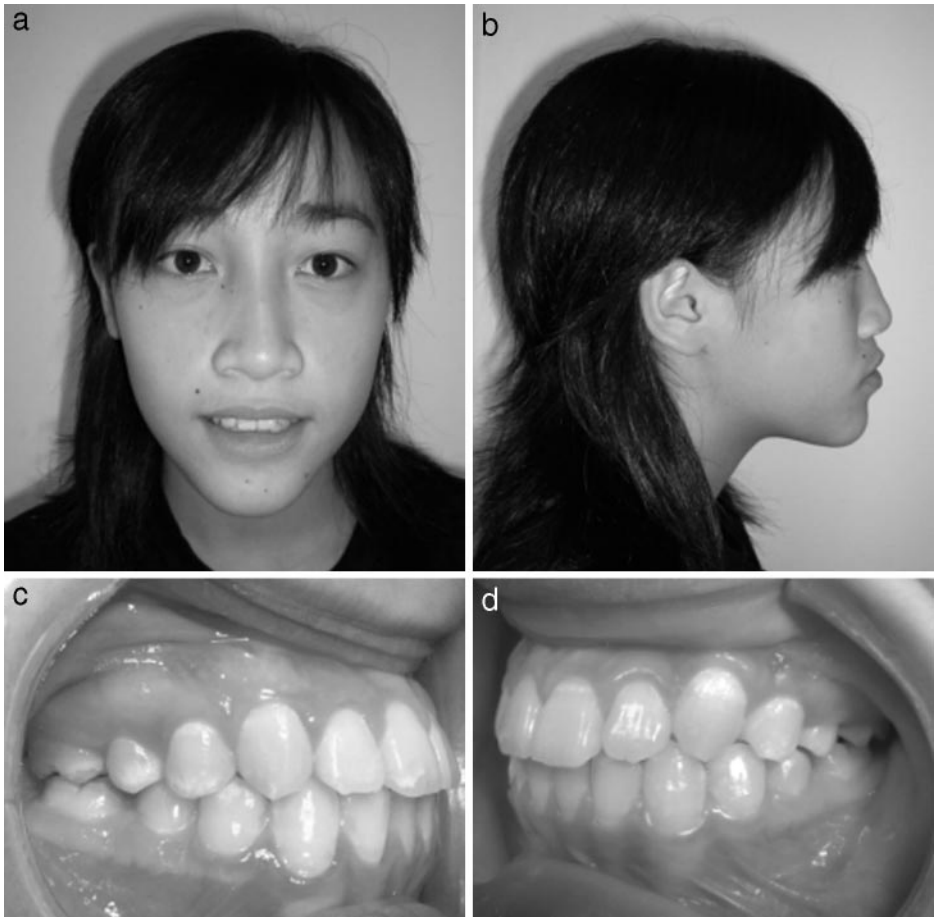

FIGURE 11. (A–D) The facial and intraoral photographs at the 17-month posttreatment follow-up shows that the midline, overjet, and overbite are still in good position. There is no sign of relapse of the left maxillary posterior teeth.

(Figure 6). This was hard to do so because the root of the canine would soon penetrate the hard palate into the sinus as the root moved into an upright position. Also, the position of the first premolar was lower than the canine. Consequently, the total extrusion force needed for the first premolar needed to be smaller than that for the canine. Having the first premolar extruded to reinforce the anchorage helped to reduce the intrusive effect during canine extrusion.

The 0.016 $\times$ 0.022–inch or larger size stainless steel archwire is commonly used as the main archwire for treatment of impacted canines. We did not use a larger size stainless steel wire as the main archwire during extrusion of the impacted teeth because the rectangular wire took up more slot space. As a result, the auxiliary archwire was more difficult to lock in and to stabilize in the bracket slot with the main archwire. Regardless, the fact that a smaller size archwire was used shows that the double archwire (DAW) technique provides a sufficient biomechanical force system for highly controlled tooth movement. The 0.016-inch stainless steel wire plus an open-coil spring alone might not be able to withstand the pulling force of vertical elastics. However, with the help of a nickel-titanium auxiliary wire, the DAW force system seems to possess a more rigid character to withstand the distortion of the archwire and thus to minimize the intrusion and tipping of adjacent teeth.

Furthermore, with the DAW technique the nickel-titanium auxiliary wire simultaneously renders great deflections without significant permanent deformation and can be placed directly into the bracket slot of the high-impacted canine or premolar. Extrusion and moving the root of a high horizontally impacted tooth into an upright position can happen simultaneously. The application of an elastic chain allows further adjustment to move the center of the force system in a desired direction. Careful application of the DAW force system allows successful and efficient treatment of the highly impacted horizontal canine and first premolar without any significant side effects on the adjacent teeth.

The upper lateral incisor roots seemed to be tipped mesially on the initial panoramic radiograph (Figure 2).

However, the root axis looked acceptable when examined on a periapical radiograph (Figure 3), and the axes of the clinical crowns of the upper lateral incisors looked normal as well. Considering that the root tip of the upper right lateral incisor was located close to the impacted canine tip, distal tipping of the lateral incisor root might have caused an accidental contact of the roots. Therefore, it was decided to maintain the original root axis of the lateral incisors. In the posttreatment panoramic radiograph, the axis of the upper lateral incisor roots appears unchanged (Figure 10).

Retention was performed with a modified Hawley retainer. No extraretentive element was provided in the left canine and first premolar region. Although Blair et al[9] reported a significant amount of relapse occurring after exposure and alignment of an impacted maxillary canine, this young female patient had no significant relapse.

The term double archwire has been mentioned in the orthodontic literature,[10,11] but it is not yet widely applied or understood. On the basis of results of this case, we may conclude that future research is needed to understand the biomechanics of the DAW technique. Further application and development of the control of the force system in the double archwire technique may help orthodontists to manage difficult cases that previously were considered as untreatable.

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