Case Report

Diagnosis, sequencing, and management of bilateral horizontally positioned, palatally impacted maxillary canines with closed surgical exposure and immediate continuous light orthodontic traction

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1. Introduction

The diagnosis, sequencing, and management of bilateral horizontally positioned, palatally impacted maxillary canines with closed surgical exposure are presented. An adult female patient presented with bilateral horizontal impactions of the canines, which were situated below the floor of the nose. The sequence and timing of the movements from the initial diagnosis of horizontal canine position are documented, along with the corresponding durations of the horizontal, vertical, and labial movements. Photographic and radiographic timeline documentation is presented, and the stages of movements are displayed, with the corresponding mechanics taking place to produce an ideal occlusion. The patient was treated to an ideal Class I occlusion with ideal facial results, without premolar extractions.

2. Diagnosis

A female patient, 28 years of age, presented for a second opinion and orthodontic consultation (Fig. 1). The patient presented with an apparent Class I malocclusion, 30% over bite, and 2-mm over jet (Fig. 2). She presented with bilateral palatal impactions of the maxillary canines, which were horizontally positioned below the floor of the maxillary sinuses. On review of the apical and panoramic radiographs, the patient’s maxillary deciduous canines were intact; in addition, no root resorption was seen on the incisors (Figs. 3 and 4).

3. Etiology

In orthodontics, canine impactions are a dental anomaly that occurs frequently. Approximately one-third of impacted maxillary canines are located labially and two-thirds are located palatally [1,2]. Localized, systemic, and genetic factors have been proposed as causes. The exact etiology of palatally displaced maxillary canines is unknown.

A study by Jacoby [3] showed that 85% of palatally impacted canines had sufficient space for eruption, whereas only 17% of labially impacted canines had sufficient space. Arch-length discrepancy may be a primary etiologic factor for labially impacted canines [4]. Other factors such as malpositioning of the tooth bud, or obstruction in the path of eruption, delayed resorption or a lack of resorption of the deciduous teeth may be additional contributing factors.

4. Treatment objectives

4.1. Maxilla

The objectives for the maxillary arch were to maintain normal anteroposterior position of the incisor with non-extraction treatment.
4.2. Mandible

The objectives for the mandibular arch were to maintain normal anteroposterior and vertical position.

4.3. Maxillary dentition

In the maxillary dentition, we planned to maintain anteroposterior angulation of the incisors, with Class I correction by distalization of the buccal dentition. Vertically, we aimed to level and align the arch. We also intended to maintain the bite and the intermolar width.

4.4. Mandibular dentition

In the mandibular dentition, we planned to maintain anteroposterior angulation of the incisors and Class I occlusion. Vertically, we aimed to level and align the arch. We also intended to maintain the bite, intermolar width, and intercanine width.

4.5. Facial aesthetics

We aimed to maintain the profile and improve the frontal smile by bringing the horizontally positioned maxillary canines into ideal Class I position, including buttressing of the alveolar processes to structurally support the corners of the patient's mouth and alar base.

5. Treatment alternatives

At the patient's first consultation, it was recommended that the maxillary permanent canines be extracted and that, after healing, the deciduous canines be extracted and implants placed at the time of the extractions. Although this approach may be successful from the standpoint of osseointegration, the aesthetic result of a smaller implant-supported crown, with time, may be less than desirable. In addition, gingival discoloration, infraocclusion of the implant crown, progressive loss of cortical bone, interdental bone loss on natural teeth near the implant, and peri-implantitis can impair the result of implant-supported crowns.

In an ideal arch, the permanent maxillary canines with the buttressing prominence of the alveolar bone are positioned at the corners of the mouth, providing arch, lip, and lateral alar support. The anatomy, the length of the root, and the labiobuccal thickness of the crown and root are very prominent. Mesiodistal crown dimension is larger than that of a deciduous canine. Comparing the size of a canines on its alveolar housing to that of a deciduous canine on its surrounding alveolar support, one can see the limitations of this sequence and the limitations of treatment. The Table 1 shows a comparison of the dimensions of a permanent maxillary canine to those of a deciduous maxillary canine [5].

A second possibility was extraction of the premolars to create space for the permanent canine repositioning. Another alternative was no treatment.

Canines play a vital role in facial appearance, dental aesthetics, arch development, and functional occlusion. Wheeler [5] and Arvystas [6] emphasized aesthetics and function of the canines by stating, "Because of their position in the arches and the length and angulation of the roots, all canines act as important underlying structures of the face, assuring sufficient prominence at the 'corners' of the mouth to bring out character, strength, and beauty" [5].

The patient's chief concerns were her smile, the small size of her deciduous teeth, the uneven contours of the gingival tissue heights between her anterior teeth, and the lack of alar base support. The natural observation is the gingival scalloping height contours of the natural dentition. The gingival tissue is higher on the central incisors (cervico-incisal length of crown 10.5 mm), drops down on the lateral incisors (cervico-incisal length of crown 9.0 mm), is higher again at the canines (cervico-incisal length of crown 10.0 mm), and again drops down on the first premolar (cervico-incisal length of crown 8.5 mm). These heights of contour are crucial for the aesthetic smiles of our patients [5].

6. Treatment progress and treatment results

Andrews 0.022-in straight wire appliances with Roth prescription were placed, with maxillary triple tube molar bands and mandibular double-tube molar bands. Leveling and alignment were achieved with progressive-gauge, round, nickel-titanium (NiTi) archwires. As the movement progressed, obviously the maxillary buccal dentition had to be distalized to provide room for the larger mesiodistal crowns of the permanent canines; 0.018-in stainless steel base archwire was inserted into

Fig. 1. Frontal smile photograph displaying constriction of maxillary arch form, with deficient alveolar development in the canine region.
the base slot, and 0.045-in Wilson distalizing arch was placed into the 0.045-in headgear tube. In addition, a mandibular 0.022 × 0.025-in archwire was placed, and Class II 3/16-in elastics with 7-oz. force from the mesial hooks of the Wilson arch to the mandibular first molar hooks were worn 24 hours/day for several months.

After space was created by distalizing the molars to make room for the permanent maxillary canines, a stainless steel 0.022 × 0.025-in maxillary archwire was placed.

The patient was sent for surgical exposure of the maxillary canines and extraction of the deciduous canine. A flap was performed, displaying the horizontal position of the canines, with the

Fig. 2. (A) Right buccal intraoral photograph displaying over-retained deciduous canine. (B) Frontal intraoral photograph displaying lack of alveolar buttressing. (C) Left buccal intraoral photograph displaying over-retained deciduous canine.

Fig. 3. Panoramic radiograph displaying palatal horizontally impacted canines below the nasal floor.
crowsns behind the roots of the central incisors; bone was removed to expose the crowns for the placement of bonded attachments that were placed on the left and right canines, with a gold chain attached. The flap was sutured closed and the chain exposed.

Active movement of both canines was started immediately, with sectional lever arm rectangular springs (0.018 \times 0.022 \text{ in}) to the maxillary rectangular base arches (0.022 \times 0.025 \text{ in}) to move the canines lingually and distally, away from the roots of the incisors. Cross elastics were worn from the buccal maxillary molar attachment to the lingual cleats of the mandibular incisors. This was done by rectangular lever arm springs.

6.1. Treatment sequencing

On August 26, 2008, overlay arches were used to move the maxillary canines labially and incisally (Fig. 6).

A maxillary 0.018-in stainless steel base arch and a 0.045-in Wilson distalizing arch, inserted into the 0.045-in headgear tube, were placed to create more space for the left canine. In addition, inserted into the utility slot was a 0.018 \times 0.022-in NiTi overlay arch, bypassing teeth and providing a greater interbracket distance, which increased the range of activation to upright the canine (Fig. 7). Note the bracket placement on the maxillary left canine. Because the straight wire canine bracket had an 11° distal tip-back for the root, a right maxillary canine bracket was placed to move the root of the left maxillary canine mesially (follow apical radiographic sequence, Fig. 8). Note the alignment of the maxillary right canine (Fig. 9) and the delayed movement of the left maxillary canine with the overlay arch (follow dated apical radiography sequence of the maxillary left canine). Figure 8 shows the progress of alignment. Once the crown of the maxillary left canine erupted (January 13, 2009), a maxillary right canine bracket was placed on the left canine to move the canine root mesially with a rectangular 0.018 \times 0.022-in NiTi overlay arch. The proper maxillary right canine bracket on the maxillary right canine and the dated apical radiography sequence of movement in the root of the left canine can be seen.

The progress of movement with the rectangular 0.018 \times 0.022-in overlay arch is shown in Figure 7 (January 20, 2009). The distalizing, spring-loaded Wilson arch is shown creating proper mesiodistal space for the left canine and overcorrection of the right canine. Improved progress of the left canine position is also shown (February 10, 2009). Once enough mesiodistal space was developed for the canine, treatment with the Wilson arch and Class II elastics was terminated. The canine roots were uprighted, proper right and left canine brackets were placed, and a new 0.022 \times 0.025-in NiTi overlay arch engaged the canine bracket (February 24, 2009).

On March 10, 2009, stainless steel, rectangular 0.018 \times 0.022-in arches were placed, with elastic chains to close the remaining residual space. On March 24, 2009 (Fig. 10), buccolingual coordination of the arches was taking place, with improved gingival contours.

The final occlusion, 4 years after retention, was a Class I occlusion with healthy gingival tissue (Fig. 11).

Figure 11D is an occlusal maxillary photograph showing the platinum-gold lingual bonded retainer from the lateral canine and the first premolars to prevent vertical relapse of the canines. Figure 11E shows an ideal occlusal arch form of the mandibular arch. Figure 12 shows the aesthetic smile of the patient, with a full dentition.

6.2. Maxillary right canine movement

6.2.1. Radiographic summary and time sequence

Maxillary right canine movement took place from December 12, 2007, to April 22, 2009 (Figs. 3, 9, and 13). Total treatment time to upright the right canine was 16 months. The maxillary right canine bracket prescription has 11° of distal angulation for the root.

6.2.2. Radiographic sequencing

The initial objective was to move the crown lingually, away from the roots of the incisors. This was done by rectangular lever arm springs. The crown was then moved labially. As soon as the crown of the canine was exposed through orthodontic movement, a left canine bracket was placed and engaged by a rectangular 0.018 \times 0.022-in NiTi overlay arch to move the canine root mesially and to upright the canine. Bypassing teeth provided a greater interbracket distance, which increased the range of activation.

6.3. Left canine movement

6.3.1. Radiographic summary and time sequence

Maxillary left canine movement took place from December 12, 2007 to July 22, 2009 (Figs. 3, 8, and 13). The maxillary right canine bracket prescription has 11° of distal angulation for the root.

Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Permanent maxillary canine</th>
<th>Deciduous maxillary canine</th>
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<tbody>
<tr>
<td>Cervicoincisal length of crown</td>
<td>10.0</td>
<td>6.5</td>
</tr>
<tr>
<td>Length of the root</td>
<td>17.0</td>
<td>13.5</td>
</tr>
<tr>
<td>Mesiodistal diameter of crown</td>
<td>7.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Labiolingual diameter at cervix</td>
<td>7.0</td>
<td>5.1</td>
</tr>
</tbody>
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Data are presented in millimeters.
Fig. 5. (A) Intraoral right buccal view displaying lever arm segmental arch attached to the right impacted canine, moving it lingually and distally away from the roots of the incisors. (B) Intraoral frontal photograph displaying lever arm segmental rectangular 0.018 × 0.022-in arches crimped on 0.022 × 0.025-in stainless steel base arch. (C) Intraoral left buccal view displaying lever arm segmental arch attached to the left impacted canine, moving it lingually and distally away from the roots of the incisors. (D) Panoramic radiograph taken at initial activation of lever arm springs to move the crowns of the canines away from the apices of the incisor roots. (E) Heavy 0.022 × 0.025-in stainless steel base arch was used to maintain arch form and provide support for the maxillary incisors. (F) Typodont illustrates the rectangular lever arm spring placement. (G) When the lever arm is activated with ligature wire, the arm moves from the mucobuccal fold incisally and lingually and is tied to the canine gold-linked chain. (H) The forces produce distolinguinal movement, labial movement, and buccal torque movement on the first molar, which is countered by cross-elastic wear from the maxillary buccal attachment to the lingual cleat on the mandibular molar.

Fig. 6. August 26, 2008. (A) Right buccal, (B) frontal, and (C) left buccal views displaying overlay arch moving canines labially and incisally.
6.3.2. Radiographic sequencing

Again, the initial objective was to move the crown of the canine away from the roots of the incisors. This was done by rectangular lever arm springs. The crown was then moved labially. As soon as the crown of the canine was exposed through orthodontic movement, a right canine bracket was placed and engaged by a rectangular 0.018 × 0.022-in NiTi overlay arch to move the canine root mesially and to upright the canine. The left canine movement required 3 extra months to achieve total uprighting with the same mechanics. Also note the similarity of their position on the panoramic radiograph at the start of treatment.

On cephalometry (Figs. 4 and 14), the superimposition of the sella-nasion plane at the nasion displays the total growth and orthodontic tooth movement in this adult female patient. The maxillary and mandibular incisor position was maintained throughout treatment, and the maxillary molars were distalized with a Wilson arch and Class II elastics. Facial growth was nonsignificant over the treatment time period.

The anterior incisor positions and transverse dimensions were maintained. Distalization of the buccal segments was achieved to create space for the larger mesiodistal dimension of the permanent canines. Once it was achieved, rectangular 0.018 × 0.022-in sectional spring arches were placed over the rectangular base arch bilaterally to move the canine crowns away from the roots of the incisors in a distolingual movement. The canines were moved from the horizontal position to an ideal position in the maxillary arch (Figs. 3 and 13). An ideal Class I occlusion was achieved with healthy gingival contours, with no resorption of the incisor roots. Facially, the frontal photograph in Figure 12A displays an ideal smile and balanced facial proportions. Total active treatment time was approximately 19 months.

7. Discussion

The diagnosis and management of impacted canines is a major concern for the orthodontic profession.

The literature indicates that the average age for maxillary canine emergence is about 12 years for girls and 13 years for boys [4,7]. A weak correlation between chronologic age and the biologic processes related to tooth development and eruption leads to...
great individual variability in eruption timing. The inability to accurately predict tooth-eruption timing based on chronologic age has led to investigations of alternative methods of prediction. Several studies using biological indicators of skeletal maturity, such as hand—wrist and cervical vertebral maturation, have reported that canines usually erupt by the end of the pubertal growth spurt [8–10].

During the evaluation of pretreatment radiography, the practitioner assesses multiple variables with regard to a nonerupted canine. In the vertical dimension, the height of the crown of the canine is noted. In the sagittal dimension, canine crown overlap of the adjacent incisors, anteroposterior position of the canine root apex, and angulation of the canine to the midline are considered [1]. In the transverse dimension, the practitioner must determine the labiopalatal position of the canine crown and apex. Finally, the adjacent incisors must be evaluated for potential root resorption based on proximity to the nonerupted canine. In one study, these factors were evaluated to determine which influenced treatment-planning decisions. The decision to expose or remove an impacted canine, based on radiographic information, was primarily guided by two factors: 1) labiopalatal crown position; and 2) angulation to the midline [11]. Recent ongoing research suggests that there may be skeletal and dental irregularities that are related to maxillary impacted canines. A study of the maxillary arch shape and palatal vault shape was done to determine if the morphology of the maxilla had any correlation to the impacted canines. Both measurements showed statistically significant differences between the buccally and palatally impacted groups. The shape of the maxillary arch was narrower and longer in the palatally impacted canine group compared with the buccally impacted canine group, and the palatally impacted canine group had a deeper palatal vault than did the buccally impacted canine group [12,13].

8. Conclusions

It is imperative in the treatment of severe horizontal maxillary canine impactions to support the premaxilla with a rectangular stainless steel base arch in conjunction with ancillary lever arm springs off of the maxillary molar attachments to move the canines away from the roots of the maxillary incisors. The use of overlay arches facilitates the movement of the canines into a labial position and in the uprighting of the roots into proper position while the base arch supports the maxillary incisors. A detailed documented sequence of treatment is presented in the movement of horizontally bilaterally palatally impacted canines into their ideal position.
in the maxillary arch. The facial harmony, maxillary prominence, and the proportionality of the smile to the face is achieved.

References


Fig. 11. (A) Frontal, (B) right, and (C) left intraoral photographs displaying ideal occlusion. (D) Maxillary and (E) mandibular occlusal views displaying ideal arch form. Note the lingual bonded platinum retainers on the laterals, canines, and first premolars. The bonded lingual retainer prevents vertical relapse of the canines.
Fig. 12. (A–C) Facial/frontal photographs displaying the smile. Note the balance and proportionality of the smile to the rest of the facial structures and the canine prominence.
Fig. 13. Post-treatment panoramic radiograph displaying the movement achieved to move the canines into the arch. Maxillary third molars were extracted before treatment.

Fig. 14. (A) Post-treatment cephalometric radiograph. Note the orthodontic movement of the maxillary canines. Distalization of the maxillary buccal dentition was achieved without anterior movement of the incisors. (B) Cephalometric superimposition on anterior cranial base (nasion–sella line), displaying total growth and orthodontic movement on pre- and post-treatment cephalometric radiographic analysis. This displays total orthodontic movements, showing minimal facial growth of the adult female patient while maintaining incisor position with posterior distalization of the maxillary molars and minimal mesial movement of the mandibular molars.

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