Correction of bilateral impacted mandibular canines with a lip bumper for anchorage reinforcement

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Multiple treatment options are available to patients with impacted mandibular canines in addition to a retained deciduous canine. This article describes the treatment of a prepubertal girl, aged 10 years 6 months, with a skeletal Class I, dental Class II Division 1 malocclusion, retrognathic mandible, deep overbite, proclined maxillary incisors, midline diastema, and bilateral mandibular canine impaction. The orthodontic treatment plan included extraction of the deciduous canine and forced eruption of the impacted canines. A modified lip bumper appliance was used both for forced eruption and to reinforce anchorage. Through the collaborative efforts of an orthodontist and an oral surgeon, an excellent esthetic and functional outcome was achieved. (Am J Orthod Dentofacial Orthop 2013;143:393-403)

In the human dentition, maxillary and mandibular canines are a necessity from both esthetic and functional perspectives. Maxillary canines are the most commonly impacted teeth after the third molars.1 Most impacted canines remain asymptomatic; however, a number of potential implications have been suggested: labial or lingual malpositioning of the impacted tooth; migration of the neighboring teeth and loss of arch length; external root resorption of the impacted tooth and the neighboring teeth; infection, particularly with partial eruption resulting in pain and trismus; and referred pain.2,3 Unerupted or partially erupted canines can increase the risk of infection and cystic follicular lesions and can compromise the life span of neighboring lateral incisors caused by root resorption.2,3

The incidence of mandibular canine impaction is about 20 times less than impaction of the maxillary canines.4 Treatment options for mandibular canine impaction are surgical extraction with premolar substitution,5 autotransplantation,6 and surgical exposure and eruption into the dental arch.7 Factors that influence the potential problems and complexity for the treatment of impacted canines are timing of the orthodontic treatment, type of surgical procedure to expose the impacted tooth, orthodontic mechanics, position of the impacted tooth in the arch,8 and eruption status of neighboring teeth. Maxillary canines erupt by the age of 11 to 13 years; when the signs and symptoms of impacted canines are evident, nearly all permanent teeth except the second and third molars are present in the oral cavity. Unlike the maxillary canines, the mandibular canines erupt by the age of 9 to 10 years, and the permanent incisors and first molars are the only other permanent teeth except the second and third molars are present in the oral cavity. This case report describes the treatment of a patient with bilateral mandibular canine impactions in the midsymphyseal region.

DIAGNOSIS AND ETIOLOGY

A girl, aged 10 years 6 months, came with a chief complaint of proclined maxillary anterior teeth and increased overjet. She was diagnosed with a skeletal Class
I and dental Class II Division 1 malocclusion with a retrognathic mandible, deep overbite, proclined maxillary incisors, midline diastema, and bilateral mandibular canine impaction.

Her medical history was not contributory. The pretreatment facial photographs showed a brachyfacial, symmetric face and a convex soft-tissue profile caused by a retrognathic mandible. Upon smiling, 7 mm (90%) of occlusogingival length of the maxillary central incisors was visible (Fig 1). The lower lip was everted, and there was no functional problem. The pretreatment intraoral photographs and dental casts showed that the patient was in the mixed dentition. The first and second deciduous molars, permanent incisors, and first permanent molars were erupted in the oral cavity. She had maxillary and mandibular dental midlines coincident with her facial midline. The overbite was deep at 70%, with the mandibular incisors touching the palatal mucosa. Overjet was 8 mm. There were 8 mm of spacing in the maxillary arch and 1 mm of crowding in the mandibular arch. The molar relationship was end-on (Class II) half a cusp width distoclusion of the molars on both the sides (Fig 2).

The pretreatment lateral cephalogram and orthopantomogram (Fig 3) showed that both mandibular canines were impacted apically and labially to the mandibular incisors, in a mirror-image-like pattern, with both canines in the midsymphyseal region of the mandible. The long axes of the right and left impacted canines had angles of $35^\circ$ and $24^\circ$, respectively, with the midline on the panoramic radiograph. The crowns of both canines could be palpated digitally in the labial mandibular sulcus. No signs of external apical root resorption were observed on the roots of the deciduous canines. The cephalometric analysis (Table) showed a skeletal Class I relationship (ANB angle, $3^\circ$) with a flat mandibular plane angle (SN-GoGn angle, $27^\circ$), a retrognathic mandible (SNB angle, $75^\circ$), proclined maxillary incisors (U1-NA, 12 mm and $59^\circ$), and upright mandibular incisors (L1-NB, 4 mm and $27^\circ$).

The reported frequencies of mandibular canine impaction range from 0.05% to 0.4%. No definitive etiology has been reported as a causative agent for
mandibular canine impactions. However, genetics, obstructions to the eruption path, and abnormal displacement of the dental lamina in embryonic life might lead to impaction or ectopic eruption of the mandibular canines.11

TREATMENT OBJECTIVES

The treatment objectives for this patient were as follows: (1) get the bilaterally impacted mandibular canine into the arch, (2) correct the deep overbite and the increased overjet, (3) close the spaces in the maxillary arch, (4) correct the malalignment of the mandibular anterior teeth, (5) achieve bilateral Class I canine and molar relationships, and (6) improve the facial balance.

TREATMENT ALTERNATIVES

The possible solutions for correction of the impacted mandibular canines were the following.

1. Extraction of the bilaterally impacted mandibular canines, while preserving the deciduous canines to function in place of the permanent canines. Although there was no obvious external apical root resorption of the mandibular deciduous canines, these teeth would not be bonded during fixed appliance treatment to prevent any resorption of their roots. After the fixed appliance phase, the vertical dimensions of these teeth would need to be restored. For the long-term preservation of these teeth, canine-guided occlusion would be avoided.12

Fig 2. Pretreatment models.

Fig 3. Pretreatment lateral cephalogram and orthopantomogram.
Table. Cephalometric analysis

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<td>SNA</td>
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<td>SNB</td>
<td>75°</td>
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<td>Gcc-FH</td>
<td>6°</td>
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<td>SN-GoGn</td>
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<td>FMA</td>
<td>20°</td>
<td>18°</td>
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<td>U1-SN</td>
<td>130°</td>
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<td>U1-NA</td>
<td>12 mm, 59°</td>
<td>7 mm, 35°</td>
<td>8 mm, 37°</td>
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<td>L1-NB</td>
<td>4 mm, 27°</td>
<td>6 mm, 33°</td>
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<td>IMPA</td>
<td>101°</td>
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<td>Y-axis</td>
<td>57°</td>
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<td>G’S-Pg’</td>
<td>153°</td>
<td>160°</td>
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<td>U1-L1</td>
<td>100°</td>
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<td>U1-A-Pg</td>
<td>14 mm</td>
<td>9 mm</td>
<td>10 mm</td>
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*U1, Upper incisor; L1, lower incisor.*

2. Extraction of the deciduous canines and autotransplantation of the mandibular permanent canines was considered as a possible solution. Only a few reports describing autotransplantation of impacted mandibular canines have been reported in the literature. To the best of our knowledge, no longitudinal study has evaluated the transplantation of mandibular canines. In the present case, the root formation of the mandibular canines was two thirds complete, making them ideal to be transplanted, but the procedure would require extensive removal of bone from the thin midsymphyseal region of the mandible, which could have jeopardized the adjacent teeth.

**TREATMENT PLAN**

Orthodontic correction of mandibular impacted canines necessitates a stable source of anchorage. The only teeth available to provide anchorage were the mandibular first permanent molars. To reinforce the anchorage, an assembly was fabricated in which both first permanent molars were connected by using a 0.040-in round stainless steel lingual arch (Fig 4). On the buccal side of the molar bands, stainless steel tubes with an internal diameter of 0.030 in were soldered. The length of the tube was adjusted so that the mesial end was at the midbuccal point of first deciduous molar. The stainless steel tubes were curved according to their respective arch-form segments. A lip bumper was fabricated from 0.021 × 0.027-in stainless steel ovoid archwire by adding self-cured acrylic resin in the incisor region. At the distal legs of the lip bumper, a few bends were made that would friction lock it once the distal legs were drawn through the stainless steel tubes. Small steel hooks were soldered onto the wire of the bumper just distal to the acrylic part for engaging the elastics. These hooks limited the distance that the leg of the lip bumper could go into the stainless steel tube, thus keeping the acrylic pad 4 mm away from the mandibular incisors and transferring the distal force from the lip to the molars.

A distalizing and extrusive force was applied by the elastomeric chain on the canines from the steel hooks soldered on the lip bumper. This force was expected to produce controlled tipping of the canines around the center of rotation at the root tip apex (Fig 5). A reactionary force acting on the molar thus might result in mesial tipping of the molar. Since the acrylic pad of the lip bumper was at the middle of the crown of the mandibular incisors, a distal force was expected to be experienced by the molars, which would counteract the mesial reactionary force (Fig 5).

**TREATMENT PROGRESS**

The maxillary incisors, mandibular incisors, and maxillary molars were bonded with a 0.022-in MBT preadjusted appliance (3M Unitek, Monrovia, Calif). In the maxillary arch, a 0.016-in nickel-titanium archwire was placed for leveling. The molar band assembly incorporating the lingual holding arch, and the soldered stainless steel tube were cemented on the mandibular molars. Surgical exposure of the impacted canines was done using a closed-eruption technique by raising a full-thickness mucoperiosteal flap and bonding a button with an attached gold chain on the crown of the impacted mandibular canines.

After 2 weeks of soft-tissue healing, the lip bumper was fitted by inserting the distal legs into the buccal stainless steel tube until the soldered stainless steel hooks came into contact with the mesial end of the tube. A force of 75 g was applied to the canines by attaching an elastomeric chain from the distal end of the gold chain to the soldered stainless steel hooks. A panoramic radiograph taken 1 month after the initial application of the force (Fig 6) showed initial uprighting of the impacted mandibular canines. The elastomeric chain was changed every 4 to 5 weeks. After 15 months of treatment, the left canine was visible in the oral cavity (Fig 7). The lip bumper was removed, the mandibular left canine and the first permanent premolars were bonded, and a 0.016-in nickel-titanium archwire was inserted for alignment of the teeth. An extrusive force on the mandibular right canine was continued from the mandibular right first premolar for the next 6 months, until it had erupted enough...
in the oral cavity to be bonded (Fig 8). The assembly (lingual arch and stainless steel tubing) on the molars was removed, and brackets were bonded to correct the mesiodistal and buccolingual positions of the canines. Progressive panoramic radiographs showed continuous eruption of the mandibular right canine and

Fig 4. Appliance design.

Fig 5. Biomechanics: $F$, Force applied by elastic power chain on canines; $Fr$, reactionary force felt by molars from $F$; $CROT$, center of rotation; $FB$, force produced by the lip bumper.
simultaneous uprighting of the roots mesiodistally (Fig 9). It took about 9 months to adjust the occlusion and get the molars and canines into a Class I relationship. The total treatment time was 30 months.

TREATMENT RESULTS

At the end of the treatment, a well-aligned dentition with Class I molar and canine relationships was achieved. The patient had a consonant smile arch, the teeth had good interdigitation, and normal overjet and overbite were achieved. The maxillary midline was coincident with the facial midline, and the mandibular midline was shifted to the right by 1 mm (Figs 10 and 11). The posttreatment panoramic radiograph showed no apparent root resorption and well-aligned root angulation of the teeth (Fig 12). The cephalometric analysis showed a decrease in ANB from 3° to 2° (Table). The proclination of the maxillary incisors was decreased (from 59° to 35°), whereas the mandibular incisors became more proclined (from 27° to 33°).

The posttreatment intraoral photographs showed normal clinical crown length of both mandibular canines. The gingival tissue looked healthy, with no gingival recession or periodontal pockets with an adequate zone of attached gingiva. There were some white spot lesions and some interdental papillary overgrowth in the mandibular labial region. Canine-to-canine lingual bonded retainers were placed in both arches. After 2 years in retention, the occlusion was well maintained, with minimal apparent gingival

Fig 6. Radiographs showing initial uprighting of the impacted canines.

Fig 7. Mandibular left canine erupted into the oral cavity.

Fig 8. Both mandibular canines erupted into the oral cavity.
recession observed in the mandibular canines (Figs 13 and 14). Overall and regional superimpositions showed favorable growth of the mandible and improvement of overjet (Fig 15).

**DISCUSSION**

Nodine\(^1\) reported that the frequency of impaction of the mandibular left canine is greater than the mandibular right canine, and there is a sexual predisposition, with

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*Fig 9.* Panoramic radiographs show continued root correction of the mandibular right canine.

*Fig 10.* Posttreatment facial and intraoral photographs.
impaction occurring more commonly in females. Joshi\textsuperscript{15} stated that absence of the developing mandibular canine under the deciduous canine delays the resorption process and results in an overretained deciduous canine. In our patient, there was no sign of physiologic root resorption of the deciduous canines, since the mandibular canines were ectopically impacted.

The mandibular canines in the pretreatment panoramic radiograph should be designated as ectopically impacted mandibular canines rather than transmigrated canines, because none had crossed the mandibular midline.\textsuperscript{15} Howard\textsuperscript{16} stated that canines that lie between 25° and 30° in the midsagittal plane are ectopically impacted, but they do not migrate across the mandibular midline. An overlap of the canines appears to exist if the angles are 30° and 50°; when this angle exceeds 50°, it results in transmigration of the canines. However, in our patient, the mandibular right and left canines had inclinations of 35° and 24°, respectively, so there was a chance of more migration of the right canine than the left. Greenberg and Orlian\textsuperscript{17} published radiographic evidence documenting ectopic movement of a canine from a position apical to the mandibular incisors to the opposite side of the arch in 30 months. Stafne\textsuperscript{18} pointed out that the greatest movement of canines takes place before complete development of their roots, and the teeth always travel in the direction of the crown. Taking the above factors into account, we started the
orthodontic correction of the mandibular canines as soon as possible. We speculated that delayed treatment might have allowed the right canine to erupt in the midline labial to the mandibular incisors, making later treatment mechanics more complex.

We could have treated this patient with 2 × 4 mechanics along with a lingual holding arch, but reactionary forces would have resulted in excessive proclination of the incisors and mesial tipping of the molars. Becker used a modified Johnson archwire appliance for the simultaneous forced eruption and alignment of an impacted maxillary central incisor. A similar assembly was used for this patient; however, the anchorage requirements were much greater, since both canines were involved, and the impacted teeth were far from their final positions in the arch. To minimize the reactionary force on the molars, a lip bumper assembly was added, which was held by friction in the buccal tubes soldered to the molar band. The lip bumper was positioned in the middle of the mandibular incisor crowns, so that it produced a distalizing and extrusive force on the molar. The distal force was expected to be in equilibrium with the reactionary force, thus preventing mesial tipping of the mandibular molars. The correct mesiodistal inclination of the mandibular molars can be appreciated on the posttreatment panoramic radiograph (Fig 12).

To minimize the need for second-order correction in the later stages of treatment, force was applied on the mandibular canines to achieve controlled tipping around the root apices. The force vector, which would have resulted in the desired tooth movement in this patient, must point distally, buccally, and occlusally. Such a force vector was created by attaching the elastomeric chain from the hooks soldered on the distal legs of the lip bumper in the region of the first deciduous molars, thus producing controlled tipping around the root apices of the canines (Figs 5-8).
Miniscrews are becoming more popular when additional anchorage is required. However, the patient was in the early mixed dentition, when the possibility of damaging the developing follicles and roots of the permanent teeth was high.20

Most studies about root resorption adjacent to impacted teeth have been done for impacted maxillary canines.21 Apart from the proximity of the impacted canine to the roots of the incisors, other factors that could increase the chances and severity of apical root resorption of the mandibular incisors in this patient were extended treatment time, mandibular incisor intrusion, and the fact that mandibular canines must pass the roots of the incisors on their way to their normal positions in the arch. During active eruption of the mandibular canines, the mandibular incisors were not ligated with archwires and were free to move if the crown of the uprighting canines hit the roots of mandibular incisors, thus reducing the chances of further damaging the roots of the incisors.

The posttreatment appearance of the gingiva, torque, alignment, and position of the impacted tooth in the arch are important factors for determining the success of the treatment.22 Gingival health is usually affected by the type of surgical procedure to uncover the impacted canine (open vs closed), eruption of the tooth through attached or movable mucosa, and the patient’s oral hygiene. Vermette et al22 found that labially impacted anterior teeth uncovered with an apically positioned flap have unesthetic results and more gingival recession than those uncovered with the closed-eruption technique. Moreover, Becker et al23 found no differences in the widths of the attached gingiva or the crown lengths, and no clinically significant differences in sulcus depth and bone support of impacted maxillary incisors treated with a closed-eruption surgical technique compared with adjacent normal incisors. Our patient was treated with the closed-eruption surgical exposure technique, and the canine was brought into the arch through the attached gingiva; this resulted in an adequate zone of attached keratinized gingiva, good bone support, and no excessive periodontal probing depths. The gingival health was maintained even 2 years after treatment (Fig 13).

Although, at the initiation of treatment, two thirds of the root formation of the canines were complete, making them ideal teeth to be transplanted, extensive surgery, anticipated bone loss, complications such as loss of the transplant, the need for an implant or other prosthetic solution, and uncertainty about the longevity of this solution made autotransplantation an alternative only if forced eruption and alignment of the canines had failed.

Because of the long treatment time, some white spot lesions were expected at the end of the treatment. The patient was advised to continue using fluoridated toothpaste and mouthwash after treatment, and the size and severity of the lesions were reduced during the 2 years after treatment (Fig 13). The treatment results were well maintained, and there has been no clinically detectable gingival recession with respect to the mandibular canines 2 years after treatment, and the long-term stability is expected to be good.

CONCLUSIONS

Alignment of ectopically impacted mandibular canines is a challenging, but achievable, option. A meticulous biomechanical plan is essential for successful resolution of such a severe malocclusion. Early intervention might be advisable in patients with impacted mandibular canines as a cautious measure, preventing possibly greater complexity of the orthodontic treatment from altered paths of eruption.
REFERENCES


Fig 15. Overall superimposition and regional superimposition (black, pretreatment; red, posttreatment; green, postretention).