A 13-year-old girl came with the chief complaint of an unesthetic dental appearance. Her maxillary canines were bilaterally impacted. Treatment included extraction of the maxillary canines and the mandibular second premolars. The maxillary first premolars were substituted for the canines. After 26 months of active treatment, the patient had a Class I molar relationship and ideal overbite and overjet. Her profile was improved, lips were competent, and gingival levels were acceptable. Cephalometric evaluation showed acceptable maxillary and mandibular incisor inclinations. Intraoral pictures taken 3 years 7 months after the end of treatment demonstrated that the extraction of impacted canines and their substitution by first premolars can be a valid alternative to traditional orthodontic treatment when maxillary premolar extraction is a treatment option.

The prevalence of impacted canines has been reported to be from 0.2% to 2.8%, and it is significantly higher in female subjects than in males (male:female ratio, 51:3). In most patients, the impacted canines are ectopically positioned. Eighty-five percent are palatal to the dental arch. However, in a recent study of 156 ectopically positioned canines, 50% were in a palatal or distopalatal position, 39% in a buccal or distobuccal position, and 11% apical to the adjacent incisor or between the roots of the central and lateral incisors. Various etiologic factors have been implicated for impacted maxillary canines: eg, ectopic position of the tooth germ, lack of space, lack of guidance, and genetic factors.

Maxillary canines play an important role in creating good facial and smile esthetics, since they are positioned at the corners of the dental arch, forming the canine eminence for support of the alar base and the upper lip. Furthermore, when the maxillary canines are properly aligned and have good shape and size, pleasing anterior dental proportions and correct smile lines are achieved. Functionally, they support the dentition, contributing to disarticulation during lateral movements in certain persons.

Impacted canines can be successfully aligned in the arches by a combined orthodontic-surgical approach, and several treatment strategies have been proposed. Such complex therapeutic management should be considered successful if the impacted canine is properly aligned in the dental arch with a healthy periodontium. However, some adverse effects related to the orthodontic extrusion of an impacted canine have been described in the literature. Differences in tooth color, alignment, vitality, probing pocket depth, and crestal bone and gingival margin heights have been reported between the previously impacted canine and its contralateral tooth. Furthermore, apical root resorption and loss of hard and soft periodontal tissues have been observed in teeth adjacent to the extruded canine.

Although the treatment of choice for an impacted canine is a combined surgical-orthodontic approach, an alternative treatment in a patient with bilateral palatally impacted canines is presented.

**DIAGNOSTIC AND ETIOLOGY**

A 13-year-old girl came with the chief complaint of an unesthetic dental appearance (Figs 1-4). The facial analysis showed a mandibular retrognathic profile, incompetent lips, perioral muscular strain, and a slightly protrusive dentition upon smiling. The intraoral examination showed a healthy periodontium,
mild maxillary transverse constriction, and moderate crowding in the maxillary and mandibular arches. A Class I molar relationship was present, and all teeth were erupted except for the maxillary canines, maxillary and mandibular right second premolars, and maxillary second molars. The panoramic radiograph showed bilateral maxillary canine impaction. The right canine was high with respect to the occlusal plane and horizontally oriented. Lack of spaces for second and third molar eruption in the mandibular arch was also noticeable. The cephalometric analysis showed an acceptable vertical and anteroposterior skeletal relationship, with moderate proclination of the maxillary and mandibular incisors (Table). A familial history of maxillary impacted canines suggested that the etiology of this malocclusion could be partially genetic.

**TREATMENT OBJECTIVES**

The treatment objectives were to maintain a Class I dental relationship, align the maxillary and mandibular dental arches, provide adequate space for the surgical extrusion of the maxillary canines, improve lip competence, and reduce dentoalveolar protrusion during smiling.

**TREATMENT ALTERNATIVES**

Nonextraction and extraction plans were considered. The maxillary and mandibular dental arches could have been aligned and leveled without the extraction of any permanent teeth by means of interproximal enamel reduction and dentoalveolar expansion. After the creation of adequate space, the maxillary canines could have been erupted by a combined orthodontic-surgical approach. However, because of the crowding, the dentoalveolar biprotrusion, and the incompetent lips, this treatment plan could have led to a more severe dentoalveolar biprotrusion and would not have addressed lip incompetence. In addition, excessive incisor proclination could have had a questionable effect on long-term stability.
Crowding associated with dentoalveolar biprotrusion is efficiently corrected by maxillary and mandibular first premolar extractions. In this patient, premolar extractions would have also addressed lip incompetence and created space for easier extrusion of the impacted canines. The anchorage could be provided by a palatal miniscrew because the bone shape was suitable. However, a long treatment time could have been required, and the risks related to orthodontic extrusion of impacted canines could not have been ruled out. In addition, because of the highly unfavorable maxillary left canine position, successful extrusion of this tooth would not have been ensured.

An alternative orthodontic treatment plan required maxillary and mandibular second premolar extractions. It would have allowed aligning and leveling of the arches, reduction of the dentoalveolar biprotrusion, and an improved facial appearance. In addition, mandibular second premolar extractions (compared with first premolar extractions) might have reduced the amount of incisor retraction during space closure, resulted in less flattening of the profile, and provided more space for easier molar eruption.

The treatment plan selected included surgical extraction of the maxillary impacted canines and the mandibular second premolars; the maxillary first premolars...
would replace the canines. This option allowed us to reduce treatment time, improve the facial profile and lip competence, and achieve alignment and leveling of the arches without incisor proclination.

**TREATMENT PROGRESS**

After extraction of the maxillary canines and the mandibular second premolars, preadjusted fixed appliances were placed, and alignment in the maxillary and mandibular dental arches was achieved by a 0.016-in thermal nickel-titanium wire. In the mandibular arch, the space closure started with lacebacks on the right and left sides (Fig 5). Then, leveling was obtained in both arches with 0.019 × 0.025-in thermal nickel-titanium wires. Maxillary and mandibular 0.019 × 0.025-in stainless steel rectangular archwires and power chain were used to close the extraction spaces (Fig 6). The finishing stage of treatment was started, and a progress panoramic radiograph (Fig 7) was taken to check for root parallelism and topography of the extraction sites. Finishing bends were placed to correct any abnormal root position and achieve marginal ridge leveling. Maxillary lateral incisor crown width was enlarged at the end of orthodontic treatment with composite buildup.

**TREATMENT RESULTS**

After 26 months of active treatment, the patient had a Class I molar relationship and ideal overbite and overjet. The profile was improved, the lips were competent, and the cephalometric evaluation showed acceptable maxillary and mandibular incisor inclinations. The final panoramic radiograph showed that good root parallelism was achieved in the anterior regions as well as across the extraction sites. The tracing superimposition showed mesial movement of the maxillary and mandibular first molars, and moderate distal movement and retroclination of the maxillary and mandibular incisors.

The gingival levels were acceptable, but a slightly higher position of the maxillary premolars and gingival margin with respect to the maxillary lateral incisors should have been achieved. The smile looked natural, and the crown anatomy of the maxillary first premolars and the accurate detailing of the incisors and the premolar positions helped in that respect (Figs 8-12, Table).

Maxillary circumferential and mandibular Hawley retainers were delivered. Intraoral pictures taken 3 years after the end of treatment show a pleasant smile. The smile line looks almost ideal (Figs 13 and 14). Oral hygiene is fair, with marginal gingivitis, but the attached gingivae are within normal limits. Gingival levels are clinically acceptable. Arch form and dental alignment are good. The patient has a Class I molar and canine occlusion, and overjet and overbite are still within normal limits. No temporomandibular joint or muscle problems developed during the retention and postretention periods. The temporomandibular joints show no clicking on opening and closing. Maximum opening of the jaws is normal, and no deviation upon opening was found. The masticatory muscles are silent. No mandibular shift was assessed upon closing, nor are premature contacts evident. Incisor and canine guidelines are present.

**DISCUSSION**

Treatment of impacted canines is a clinical challenge, because it is an interdisciplinary therapeutic approach that involves both orthodontic and surgical procedures. The outcome of treatment of impacted canines is successful when the tooth is in a stable position and the dental arch has a healthy periodontium.13 However, an orthodontic-surgical approach can result in several complications such as displacement and loss of vitality of the adjacent incisors, canine ankylosis or loss of vitality, recurrent pain, internal resorption, cystic degeneration, external root resorption of the canine and adjacent teeth, loss of periodontal bone support, or combinations of these factors.11 The external resorption of the adjacent teeth is a major concern, and this most common sequel of impacted canine treatment can result in tooth loss.14 Ericson and Kurol6 in

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**Table.** Cephalometric measurements

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
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<tbody>
<tr>
<td>Horizontal skeletal</td>
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<tr>
<td>SNA (°)</td>
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<td>SNB (°)</td>
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<td>Mandibular skeletal</td>
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<tr>
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<td>7.6</td>
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<tr>
<td>Mandibular skeletal</td>
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<td></td>
</tr>
<tr>
<td>(Pg-Na perp) (mm)</td>
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<tr>
<td>Vertical skeletal</td>
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<td>Mandibular plane to occlusal plane (°)</td>
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<td>Anterior dental</td>
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<tr>
<td>IMPA (°)</td>
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<td>87.9</td>
</tr>
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a computed tomography study of 156 ectopically impacted maxillary canines, claimed that the percentage of lateral resorption described was 38%, lower than the reported percentage of 66.7% by Walker et al.15

In the long-term results of the orthodontic-surgical approach for treatment of impacted maxillary canines, D’Amico et al16 reported the procedure’s side effects observed in a sample of 61 patients: 6.5% of the patients were dissatisfied with the esthetic results, whereas the orthodontist who clinically evaluated the patients found good results in only 57% of them. The same authors found that the inclination of the previously impacted canines was significantly different from that of the

Fig 5. Progress intraoral photographs: leveling and aligning.

Fig 6. Progress intraoral photographs: closing the extraction spaces.

Fig 7. Progress panoramic radiograph.
normally erupted canines, leading to a less frequent canine guidance on the working side during lateral movements of the mandible.

Data from the literature confirm the clinical experience that the combined orthodontic-surgical treatment is associated with several risk factors. Accordingly, a treatment alternative to eliminate these risks could be to extract the impacted tooth and treat the patient as an extraction case. Surgical extraction of the maxillary impacted canines eliminated all the risk factors and uncertainty related to orthodontic extrusion of an impacted canine. As Thoraton stated, there is no scientific evidence that one occlusal scheme is superior to the other. In that respect, canine guidance can well be supplied by premolar guidance or a group function, since the maxillary first premolar is aligned slightly extruded with respect to its normal position.

Another possible clinical concern related to maxillary premolar substitution is smile esthetics. The maxillary first premolar is a shorter tooth than the maxillary canine, thus leading to possible vertical position differences in gingival levels or occlusal margins, depending on the final vertical position of the premolars. In case of space closure and canine substitution in congenitally missing lateral incisor patients, Rosa and Zachrisson recommended intruding the first premolars to level the gingival margins and restoring the premolars with composite resin buildups or porcelain veneers to resemble natural canines and produce a balanced smile. In this patient, canine guidance was obtained by slightly extruding the maxillary first premolars. It was decided to accept a slight vertical gingival level discrepancy, and neither crown lengthening surgical procedures nor restorative buildups were performed. This conservative approach was possible because the maxillary first premolar crowns were long, with prominent buccal cusps and adequate mesiodistal widths. In addition, a slight negative crown torque was introduced in the finishing stage to produce a natural aspect as similar as possible to a maxillary canine. Alternatively, intrusion of the maxillary first premolars would have leveled the gingival margins, but lateral discision could have been lost, and a buildup restoration would have been needed.
We decided to extract the mandibular second premolars to have 2 main clinical advantages: to reduce the amount of mandibular incisor retraction during space closure, and to increase the amount of space for the mandibular second molars. However, mandibular second premolar extraction can have 2 main disadvantages: (1) the interproximal contact point between the mandibular first molar and the first premolar might not fit properly because mandibular first premolar anatomy often resembles canine anatomy rather than that of the mandibular second premolar; and (2) after mandibular second premolar extraction, the mandibular first molar might encounter an obstacle in sliding mesially into a narrower alveolar ridge that results in difficult space closure. This patient’s mandibular first premolar anatomy was carefully evaluated, and the mandibular first premolars were judged to have good shape (quite flat interproximal surfaces) and size. Therefore, final mandibular posterior interproximal contact points were clinically acceptable, and the adequate postextraction alveolar ridge thickness allowed for uncomplicated mandibular first molar mesial movement.

CONCLUSIONS

The surgical extraction of impacted canines and their substitution by first premolars could be a valid
alternative to traditional orthodontic treatment when maxillary premolar extraction is a treatment option. This treatment alternative is a valuable option that eliminates the risks associated with orthodontic-surgical treatment of impacted canines. Good functional and aesthetic results can be achieved, if an accurate and detailed anterior tooth position is managed during orthodontic finishing.

Fig 12. Superimposed tracings.

Fig 13. Intraoral photographs 3 years 7 months after the end of treatment.

Fig 14. Photographs 3 years 7 months after the end of treatment.
REFERENCES