Surgical-orthodontic management of an adult skeletal Class III malocclusion with canine substitution

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Management of missing lateral incisors requires thorough treatment planning and an interdisciplinary approach. Occlusion and alignment are significant considerations. Three treatment options are available for replacing missing lateral incisors: canine substitution, tooth-supported restorations, and single-tooth implants. The ideal treatment is the one that satisfies the esthetic and functional requirements of the patient. The pros and cons of the various treatment options must be meticulously analyzed before arriving at a decision. This article closely examines patient selection and illustrates the importance of interdisciplinary treatment planning in an adult treated with canine substitution and orthognathic surgery. ORTHODONTICS (CHIC) 2012;13:e208–e219.

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Surgical treatment is the preferred and most stable treatment option for adults with severe skeletal Class III malocclusions. A poor facial appearance is often the patient’s chief complaint, but it may be accompanied by functional problems or psychosocial handicaps. Situations requiring the extraction of periodontally compromised maxillary lateral incisors could complicate treatment, as thorough treatment planning and an interdisciplinary approach are needed.

Management of patients with missing lateral incisors can be quite challenging. The various treatment options available to replace missing lateral incisors are canine substitution, tooth-supported restorations, and single-tooth implants. Each has its own advantages and limitations, which have to be carefully analyzed before determining the treatment plan.

The decision to close the space by either canine substitution or prosthetic replacement has to be made with care, and selecting the appropriate option depends on the malocclusion, specific space requirements, crowding, profile, crown shape and color, as well as the smiling lip level. The ideal treatment is the one that is least invasive and satisfies individual esthetic and functional requirements.

Creating an orthodontic space opening for replacement with a tooth-supported restoration or single-tooth implant has been reported to be advantageous both functionally and occlusally, since it favors an ideal intercuspation of canines.
through first molars. In addition, minimal equilibration and reshaping are required on sound teeth.

The major disadvantage of orthodontic space opening is that it commits the patient to a permanent prosthesis in an area of the mouth in which tooth shade, gingival contour, and margins are critical and not always easy to control. Gingival recession and dark margins along porcelain crowns are also possible. The frequent lack of complete gingival papillary fill around implant crowns might also have esthetic consequences.

Bone loss on neighboring teeth was shown in a 10-year follow-up study of implant-supported crowns replacing maxillary incisors, which was observed as a progressive reduction of the interdental marginal bone level at the teeth adjacent to implants in some patients.

The advantages of space closure with canine substitution are the avoidance of long-term maintenance of the prosthetic replacement of the lateral incisor with a denture, fixed/removable partial denture, or implant, which can have future retreatment requirements and cost implications. Patients who had space closure were found to be periodontally healthier than those with prostheses; there was no significant difference in occlusal function and prevalence of temporomandibular dysfunction.

An argument in favor of closure is that eventual complications with the non-invasive or minimally invasive procedures are relatively easy to redo, correct, or repair, whereas complications with implant crowns are difficult, if at all possible, to amend.

The drawback in the canine-substitution method is the difficulty in achieving an acceptable esthetic outcome because of the inherent size, shape, and shade differences between maxillary canine and lateral incisors. The canine has a broader neck and usually a shade darker than the incisors. The gingival margin of the canine is usually higher than that of the lateral incisors. If these differences are not compensated, the esthetic outcome would be compromised.

Several techniques help in masking the difference between the canine and lateral incisors. The canine bracket has to be inverted to increase the palatal root torque to reduce the eminence of the canine. The bracket is positioned more gingivally to extrude the canine along with its gingival margin; the canine tip can then be reduced. The canine is bleached after orthodontic treatment to lighten the shade and improve esthetics.

Numerous studies have been done to find the range at which the layperson becomes esthetically concerned regarding the midline shift and occlusal cant. Some authors have demonstrated that maxillary midline discrepancies of more than 2 mm were likely to be noticed by laypeople, whereas others found that laypeople could not perceive a 4-mm deviation.

Asymmetry, even among esthetically pleasing faces, is a typical finding. An occlusal cant is a form of asymmetry that is apparent when a person smiles but is not perceived on intraoral images or study casts. The incisal plane inclination is an esthetic concern for the orthodontist, which must be corrected during treatment. However, Kokich et al found that laypeople did not detect this type of asymmetry until it reached 3.0 mm (equivalent to 4 degrees). Results of other studies have shown that deviations in cant are not noticeable unless they exceed 2.18, 3.16 or 4 degrees.

Canine substitution could be one of the options, instead of replacement of the lateral incisor with implants. The presurgical treatment objectives are completely different, particularly the molar relationship on the side of canine substitution. This article demonstrates how such a procedure can help achieve reasonable esthetics without the need for prosthetic replacement of the missing tooth.
CASE REPORT

Diagnosis

A 23-year-old Asian man presented with the chief complaints of unesthetic facial and dental appearance (Fig 1). He reported a history of facial trauma as a child, and there was no family history of a Class III malocclusion. The patient had poor self-esteem and would not even smile for the pretreatment facial photographs. The profile was concave, with low mandibular plane angle. The lips were competent, and the nasolabial angle was normal with no mentalis strain. Vertical facial proportions were normal, and there were no significant asymmetries.

Intraoral examination and study casts (Fig 2) revealed moderate crowding in the mandibular incisors and severe crowding in the maxillary incisors, a bilateral Class III molar relationship, reverse overjet of 3 mm, and a 7-mm deep bite. He had a full complement of permanent teeth, except for the maxillary right and left third molars, which were partially erupted and unerupted, respectively. He had mild generalized dental fluorosis, and the maxillary midline was shifted to the left by 3 mm. There was a 3-degree occlusal cant toward the left side, which was obvious when the patient smiled.

There was significant mobility of the maxillary left lateral incisor, possibly due to the poor bone support, with a deep pocket of 8 mm on the palatal aspect. There was significant extrusion of the maxillary incisors compared with the maxillary molars, which was contributing to the deep bite.

A pretreatment lateral cephalogram and panoramic radiographs were taken (Fig 3). Cephalometric analysis indicated features of skeletal crossbite (Table 1). The maxilla was significantly retrusive relative to the cranial base, while the mandible was moderately protrusive indicating a skeletal Class III relationship.

The maxillary incisor to NA plane (28 degrees, 7 mm) and mandibular incisor to NB plane (24 degrees, 4 mm) and to A-Pog (7 mm) and an interincisal angle of 129 degrees were noted. The upper and lower lip to esthetic plane was measured as −9 and −2 mm, respectively. The IMPA was 95 degrees, and the mandibular plane angle was low. The nasolabial angle was 93 degrees.
After thorough clinical examination and analysis, surgical-orthodontic treatment was recommended. The primary treatment objectives were to correct the Class III malocclusion and improve the patient’s facial esthetics. More specifically, treatment was designed to resolve the anterior crossbite, substitute the maxillary left canine in the place of the periodontally compromised and mobile maxillary left lateral incisor, eliminate the maxillary and mandibular arch-length
deficiencies, correct the overjet and overbite, align the arches and midlines, and establish a functional occlusion. It was decided to establish a Class I molar relationship on the right side and a Class II molar relationship on the left after the canine-substitution procedure and reshape the maxillary left canine to resemble a lateral incisor, since the patient was not interested in an implant.

In the maxillary arch, extraction of the left lateral incisor with presurgical leveling and alignment was carried out. In the mandibular arch, the incisor protrusion would remain the same, and the tooth-size discrepancy would be addressed through anterior interproximal reduction. Surgery would include a Le Fort I osteotomy with 6-mm advancement followed by rigid internal fixation with a plate and screws.

Treatment progress
Glass-ionomer cement was placed on the occlusal surfaces of both mandibular first molars to help open the bite and facilitate placement of preadjusted edgewise 0.022-inch maxillary and mandibular fixed appliances. Initial leveling and alignment were performed with round nickel-titanium (Ni-Ti) archwires in both arches (Fig 4). The third molars and the maxillary left incisor were extracted during the course of the treatment. The maxillary arch was leveled using a 0.016 × 0.022-inch Ni-Ti archwire with an accentuated curve of Spee.
Subsequently, 0.017 × 0.025-inch maxillary and mandibular Ni-Ti archwires were placed, followed by 0.019 × 0.025-inch stainless steel archwire. Presurgical treatment took 12 months. Le Fort I advancement surgery was performed, followed by rigid internal fixation with a plate and screws, resulting in 6 mm of maxillary advancement (Fig 5).

Intermaxillary elastics were placed immediately after surgery to maintain the result. The patient was monitored closely after the procedure and was taught to perform opening and lateral movement exercises. Orthodontic treatment was resumed 6 weeks after surgery, and canine reshaping was done followed by composite veneering to improve the esthetics. The appliance was debonded 1 year after surgery, and a retention program was initiated.

**Treatment results**
All treatment objectives were fully achieved, including an ideal overjet and overbite with Class I molar relationship on the right side and a Class II molar relationship on the left side. The missing maxillary left lateral incisor was substituted by mesial translation of the left canine and reshaping it along with composite veneering. The smile was esthetically pleasing, and the patient was happy with the final result and had an improvement in confidence level (Figs 6 and 7). He had no inhibitions in smiling and was happy and eager to pose for the posttreatment photographs.
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The concave facial profile was improved with the achievement of a straight profile with restoration of facial balance (see Fig 6b). There was improvement in the lip prominence.

Superimposition of pre- and posttreatment cephalometric tracings confirmed the treatment success (Fig 8). The posttreatment panoramic radiograph showed little or no root resorption (Fig 9). Acceptable occlusion and good

Fig 6  Posttreatment extraoral photographs.

Fig 7  Posttreatment intraoral photographs.
periodontal health were observed at the 2-year follow-up, indicating long-term stability (Figs 10 and 11). The patient was given the option of replacing the composite laminate in the maxillary left lateral incisor with a more esthetic ceramic laminate, but the patient refused the replacement since he was satisfied with the treatment outcome.

Fig 8  Pre- and posttreatment superimposition.

Fig 9  Posttreatment radiographs.
DISCUSSION

The major treatment approaches for replacing maxillary lateral incisors are space closure by canine substitution or space opening to allow prosthetic replacement with either a fixed prosthesis or single-tooth implant. This decision will depend upon several factors, including the patient's age, attitude toward orthodontic treatment, treatment expectations, and financial obligations.20
To substitute canines for maxillary lateral incisors, the permanent canines are moved mesially adjacent to the maxillary central incisors. Lateral incisor brackets are placed on the substituted canines, at a distance from the gingival margin such that they would erupt these teeth to the appropriate lateral incisor vertical height. The canine tips may be recontoured to mimic lateral incisors, thus leveling the gingival margin. By placing canines at the proper vertical height, esthetic gingival contours can also be achieved. The gingival margin of the substituted canine is positioned slightly incisal to the central incisor gingival margin to achieve optimal esthetics.

Selecting the appropriate patient for canine substitution depends on several factors. The type of malocclusion plays an important role in choosing this option for replacement of missing lateral incisors. Two types of malocclusions that permit canine substitution are an Angle Class II malocclusion with no crowding in the mandibular arch and an Angle Class I with sufficient crowding to necessitate mandibular extraction. A balanced relatively straight profile is ideal. Our patient had a skeletal and dental Class III with concave profile pre-treatment, which was surgically corrected to achieve a straight profile with a Class I molar relationship on the right side and a Class II molar relationship on the left side, where canine substitution was done.

The color and shape of the canines are important factors to consider for achieving optimal esthetics. Given that our patient had a mild generalized fluorosis, so the canine shade matched that of the central incisors, and the fact that the labial convexity of the maxillary left canine was minimal, canine substitution was the treatment option for this patient.

The narrow mesiodistal crown width at the cementoenamel junction helped achieve a more esthetic emergence profile in this patient.

Canine-protected occlusion is not feasible with orthodontic space closure. As a result, the forces generated through canine guidance are placed on the smaller and thinner roots of the first premolar. Some investigators fear loss of periodontal attachment due to the stress placed on the premolars. However, long-term periodontal and occlusal studies have shown that space closure with premolar substitution for canines can lead to acceptable functional relationship, with modified group function on the working side.

Nordquist and McNeill found that patients with canine substitution were significantly healthier periodontally than those with prosthetic lateral incisors; there was no difference in adequacy of occlusal function between the two groups, and there was no evidence to support that establishing a Class I canine relationship should be the preferred mode of treatment.

Robertson and Mohlin re-evaluated 30 patients who had undergone canine substitution and 20 patients who had prosthetic replacements for missing lateral incisors and found that canine-substitution patients were more satisfied with the treatment results than the prosthesis patients; there was no difference in the two groups in prevalence of signs and symptoms of TMJ dysfunction; and patients with prosthetic replacements had impaired periodontal health with accumulation of plaque and gingivitis.

They concluded that orthodontic space closure with canine substitution does not impair TMJ function and encourages periodontal health in comparison with prosthetic replacements, and it produces results that are well accepted by patients.

A study by Armbruster et al showed that laypersons ranked photographs of canines as lateral incisors more attractive when compared with photographs comprising cases with implants and resin-bonded fixed partial dentures.

The tendency of the space between the anterior teeth to reopen is supposed to be a major disadvantage of space closure. However, this tendency after treatment can be overcome with long-term fixed retention with a bonded
lingual retainer and proper restoration of the central incisors and first premolars adjacent to the substituting canines, supported by a well-balanced functional occlusion with modified group function on the working side.

The final outcome should be supplemented with a removable plate to be used continuously for 6 months and then at night. No apparent adverse effects were noticed with this regimen in a 10-year follow-up study.28

The major advantages of orthodontic space closure is the permanence of the finished result. It is also less invasive and more cost-effective. The need for removable retainers until the prosthesis is completed and patient dependence on a permanent restoration is avoided.5,29 The long-term adaptations of the teeth and the supporting structures will appear natural.11

Studies have shown the acceptable limit of midline shift to be between 2 and 4 mm, beyond which would be perceptible to laypersons. Despite having a pretreatment midline shift of 3 mm toward the left, our patient was not aware of it. Studies have also shown that an incisal cant range of 2 to 4 degrees was perceptible to the layperson.16,18,19 Our patient had an incisal cant of 3 degrees and was aware of the esthetic concern it posed during a smile.

The midline shift and incisal cant were corrected posttreatment, as were achievement of a straight profile and restoration of facial balance. The canine-substitution procedure resulted in good esthetics, and the patient was highly satisfied with the overall treatment outcome.

**CONCLUSION**

Surgical-orthodontic treatment is sometimes the only option for achieving an acceptable occlusion and a good esthetic result in a patient with a Class III dentofacial deformity. If there is a missing maxillary lateral incisor, or there arises a necessity to extract a maxillary lateral incisor during the course of treatment, canine substitution could be one of the treatment options. Patient selection depends on the type of malocclusion, profile, canine shape and color, and smiling lip level.

Pretreatment evaluation of these selection criteria is necessary to ensure treatment success and predictable esthetics. The entire treatment should be performed by an experienced multidisciplinary team to ensure a satisfactory outcome.
REFERENCES