

Congenitally missing maxillary lateral incisors: Canine substitution

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Clinical orthodontics is a service that should be grounded in science and biology. The science of decision in treatment planning implies identification of alternative procedures, prediction of the relative odds in favor of the desired long-term outcome for each option, and evaluation of the relative cost-risk-benefit ratios of each alternative. The decision should be comprehensible to the patient or parents and best meet the patient's needs. Whether canine substitution, single implants, or tooth-supported restorations is the method of choice for patients with missing maxillary lateral incisors, many challenges are involved in obtaining and retaining an optimal result.

RATIONALE FOR SPACE CLOSURE

Maxillary lateral agenesis is generally diagnosed in children at a young age. Therefore, the most important treatment decisions must be linked to the long-term outcome, since change over time is normal in biologic systems. The treatment result should preferably be completed when the patients are in their young teens and should be expected to reflect a natural dentition over a long life, which might span 60 or more years. Conventional space closure for missing maxillary lateral incisors is a viable and safe procedure that provides satisfactory esthetic and functional long-term results.¹⁻⁴ Further improvements by orthodontists in tooth reshaping^{2,5} and positioning⁶⁻⁸ and progress in restorative treatment with individual tooth bleaching, thin porcelain veneers,⁹ and hybrid composite resin buildups demonstrate that quality treatment can be

obtained when space closure is combined with esthetic dentistry. Close teamwork with a skilled prosthodontist is fundamentally important for the final outcome. Such results can be almost indistinguishable from natural dentitions (Figs 1, B, and 2, B)⁶⁻⁸ and are likely to remain so in a life-long perspective.⁷ Properly made ultrathin-thin enamel-bonded ceramic veneers have proved to be esthetic and extremely durable restorations.⁹

In comparison, although high survival rates for implants and implant-supported crowns can be expected, biologic and technical complications are frequent, and may appear even after only a few years.¹⁰⁻¹² A major problem with implants is that at present it is not possible to predict either when, to what degree, or in which patients unesthetic soft- and hard-tissue changes around implant-supported porcelain crowns in the anterior maxilla will occur.¹³⁻¹⁶ For this reason, it is our opinion that, if the treatment plan in young patients must include space opening, it might be preferable to open the spaces posteriorly and place implants in the premolar areas (Fig 2).⁸ For adults, decisions on whether to use space closure or implants should be discussed in interdisciplinary cooperation. Frustrating practical problems can arise when the orthodontic treatment is finished in adolescents and a waiting period of 5 or more years is needed before placing the implant. Temporary restorations with resin-bonded fixed partial dentures (FPDs) or a removable plate with plastic teeth is rarely appreciated, and adjacent roots might move so much in the interim period that orthodontic retreatment is necessary.¹⁷ This is illustrated in Figure 2, B.

Restorative procedures other than implants, including resin-bonded FPDs, cantilevered FPDs, and conventional full-coverage FPDs can be used with success in favorable situations, although debonding over time might be a common cause of failure.¹⁸ New developments with bondable translucent ceramics with adequate strength have shown promising results when a cantilevered lateral pontic is bonded to a canine.

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NO EVIDENCE FOR ESTABLISHMENT OF CLASS I CANINE RELATIONSHIP

Long-term periodontal and occlusal studies have shown that space closure can lead to an acceptable functional relationship, with a modified group function on the working side. Nordquist and McNeill³ reexamined 33 treated patients with at least 1 missing maxillary lateral incisor (39 with space closure, and 19 with space reopening and FPDs). The mean postorthodontic treatment interval was 9 years 8 months, with a range of 2.3 to 25.6 years. They found (1) that patients with lateral incisor spaces closed were significantly healthier periodontally than those with prosthetic lateral incisors, (2) no difference in adequacy of occlusal function between the 2 groups, and (3) no evidence to support that establishing a Class I canine relationship should be the preferred mode of treatment.

More recently, Robertsson and Mohlin⁴ reevaluated 50 treated patients with lateral incisor agenesis (mean age, 26 years; range, 18-55 years). The mean time after treatment was 7.1 years (range, 0.5-13.9 years). Thirty patients had received space closure, and 20 had space opening with fixed restorative options, but not implants. They found that (1) the space-closure patients were more satisfied with the treatment results than the prosthesis patients, (2) there was no difference between the 2 groups in prevalence of signs and symptoms of temporomandibular joint dysfunction, and (3) patients with prosthetic replacements had impaired periodontal health with accumulation of plaque and gingivitis. It was concluded that orthodontic space closure produces results that are well accepted by patients, does not impair temporomandibular joint function, and encourages periodontal health in comparison with the prosthetic replacements.

COMMON ESTHETIC PROBLEMS WITH ORTHODONTIC SPACE CLOSURE

Some common objections to orthodontic space closure are that the treatment result might not look "natural," the functional occlusion is compromised, and the retention of the treatment result is difficult. Particularly in patients with unilateral agenesis, space closure can create a problem in matching size, shape, and color. This is because the canine normally is longer and larger (mesiodistally and labiolingually) than the lateral

incisor it will replace (Fig 1, A), and more saturated with color. The first premolar is generally shorter and narrower than the contralateral canine (Fig 1, A). If these differences are not compensated for, the esthetic outcome will be compromised. It seems to be common among orthodontists not to fully address the natural size difference between a first premolar and a canine, so that the premolars substituting for canines are too diminutive.¹⁹⁻²²

INTEGRATING ESTHETIC DENTISTRY AND SPACE CLOSURE

Our appreciation of the space-closure alternative has increased during the last decade, as we have tried to improve our results by combining properly detailed orthodontic treatment with techniques from esthetic dentistry.⁶⁻⁸ This technology can include the following.

1. Careful correction of the crown torque of mesially relocated canines to mirror the optimal lateral incisor crown torque, along with providing optimal torque and rotation for the mesially moved premolars.
2. Intentional bleaching or a porcelain veneer to transform any yellowish or dark canines into an optimal lateral incisor shade (Figs 1 and 2).⁶⁻⁸
3. Individualized extrusion and intrusion during the mesial movement of the canine and the first premolar, respectively, to obtain an optimum level for the marginal gingival contours of the anterior teeth.
4. Increasing the length and width of the intruded first premolars with porcelain veneers or resin buildups.
5. Simple minor surgical procedures for localized clinical crown lengthening.
6. We have also recommended that clinicians should evaluate and eventually restore the central incisors. In many patients with lateral agenesis, the central incisors are small.²³
7. Widening and lengthening the incisors could allow patients to more optimally display their dentition during speech and smiling.⁸ This applies not only to canine substitution cases, but also when spaces are opened and the missing lateral incisors are replaced with restorations.

The interdisciplinary approach can achieve not only an optimal occlusion, but also a well-balanced,

The major advantages of orthodontic space closure for young patients with lateral incisor agenesis and a coexisting malocclusion are the permanence of the finished result and the possibility to complete treatment in early adolescence.

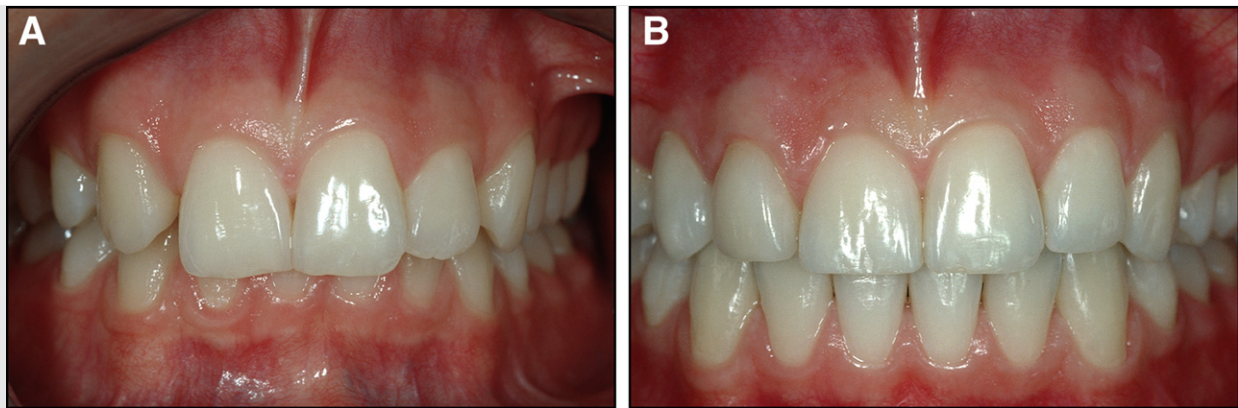


Fig 1. A, Unilateral agenesis of the maxillary right lateral incisor in a 14-year-old girl. Note the midline deviation toward the agenesis side and the deep overbite. The treatment of choice was canine substitution on the right side and extraction of the left first premolar. **B**, At the end of treatment, porcelain veneers were placed on the intruded first premolar (substituting for the canine) and the extruded canine (replacing the missing lateral incisor), respectively. The maxillary midline was intentionally slightly overcorrected relative to the mandibular teeth. The tooth sizes, shapes, and colors are almost identical on both sides. The canine substitution side might look more natural than the intact left side.

natural smile that will be stable over the long term.

ADVANTAGES OF ORTHODONTIC SPACE CLOSURE

The major advantages of orthodontic space closure for young patients with lateral incisor agenesis and a coexisting malocclusion are the permanence of the finished result and the possibility to complete treatment in early adolescence.^{1,2,7} The alveolar bone height in the actual region is maintained by the early mesial movement of the canine, and the need for removable or resin-bonded retainers until implants are placed is avoided. Adaptive changes that will take place after treatment will be natural. An ultrathin porcelain veneer can be placed directly on any anterior tooth, because the 2 common reasons to postpone permanent prosthetics in young patients (risk of pulp perforation and exposure of gingival crown margins during tooth eruption) are not contraindications for the minimally invasive preparation with enamel-bonded porcelain.

DISADVANTAGES OF ORTHODONTIC SPACE CLOSURE

The tendency of the space between the anterior teeth to reopen after space closure in a young patient is a disadvantage of this treatment option.²⁴ However,

this tendency after treatment can be overcome with long-term fixed retention with a bonded lingual retainer²⁵ and proper restorations 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 side effects were noticed with this regimen in a 10-year follow-up study.²

POTENTIAL PROBLEMS WITH OSSEOINTEGRATED IMPLANTS

As discussed elsewhere, complications around implant-supported crowns are frequent.^{8,26} There are various reasons why a word of caution is warranted.

Because of age changes in tooth position, an osseointegrated implant is, by definition, ankylosed and cannot change position, in contrast to the neighboring natural teeth. Occlusion over time is a result of developmental and adaptive processes to which facial growth, dynamic interrelationships between aging facial structures, dental eruption, function, tooth wear, and orthodontic relapse can contribute.¹³ These processes show much individual variation throughout life.^{13-16,27-29} Even small tooth movements after implant placement can cause esthetic problems.^{12-16,18} Progressive infraocclusion can occur after some years because of the continuous eruption of adjacent teeth, even in adults and elderly patients.^{8,13-16} The disharmonious marginal gingival levels resulting

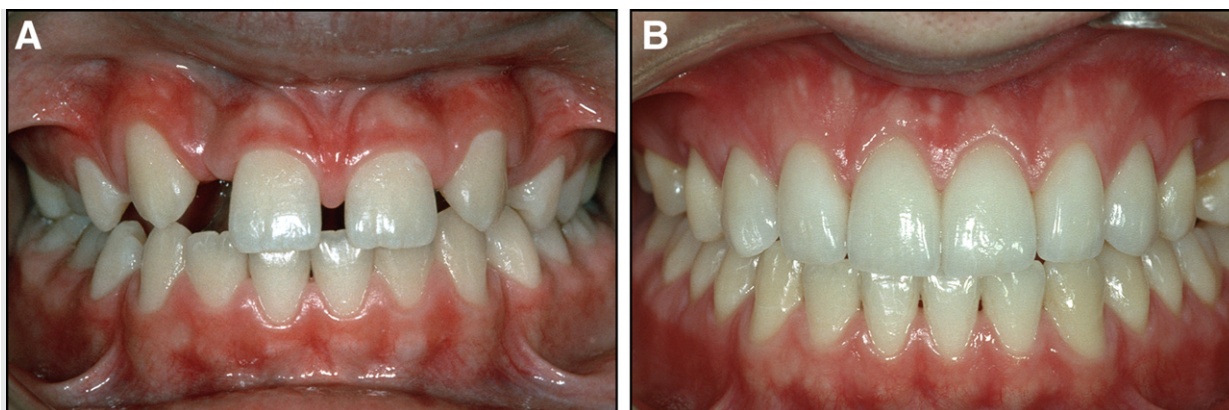


Fig 2. A, Bilateral agenesis of the lateral incisors in a 13-year-old boy with Class III and open-bite tendency. The treatment plan comprised anterior space closure with space opening distal to the second premolars for implant placement in this location when skeletal growth was completed. **B**, The orthodontic treatment lasted for 2 years 2 months and included intrusion of the first premolars (replacing the canines) and extrusion of the canines (substituting for the lateral incisors), and crown torque corrections. The upper and lower midlines were perfectly coincident at appliance removal, with proper interdigitation posteriorly. After treatment, porcelain veneers were made on 6 anterior teeth from the right to the left first premolars. Because of the vertical deficiency, the anterior veneers were lengthened to obtain adequate overbite and incisor display. In the 7-year period before planned implant placement, the patient used a removable plate to retain the opened spaces. Since it is almost impossible to use a removable plate conscientiously for so many years, some relapse occurred in the maxillary left quadrant. The space for the implant became insufficient, and a midline deviation occurred, necessitating retreatment at 22 years of age. In retrospect, a resin-bonded bridge or a bonded wire would probably have been a safer space maintainer.¹⁷

from infra-positioned implant crowns are a disadvantage for patients with a high smile line. In our opinion, a gummy smile is a contraindication for implants in the anterior maxilla.⁸ In addition, the normal uprighting of maxillary and mandibular incisors that generally occurs from adolescence to adulthood (resulting in increased interincisal angles^{30,31}) cannot be matched by implant crowns. This means that the implant crown might become more infraoccluded and protrusive over time.^{15,16}

Blue coloring of the gingiva and resorption of the labial bone have been reported. Darkening of the labial gingiva has recently been reported above more than 50% of single-implant crowns at 4-year follow-ups.¹¹ Such blue coloring is caused by resorption of the alveolar bone below the alveolar mucosa. This bone is endosteally derived and more porous (more vascular with more marrow space) and more prone to resorption^{32,33} than the periosteal bone in the zone covered by keratinized gingiva, which is formed from continuous tooth eruption.³²⁻³⁴ The buccal bone plate in the lateral incisor area is often thin, but progressive resorption can occur even when the implant had sufficient alveolar bone support at placement.^{13,15,16}

Gingival recession and dark margins along porcelain crowns are also possible. The marginal and interdental gingival tissue surrounding an implant crown is unlikely to remain unchanged over a long time span. Gingival recession might occur from overzealous toothbrushing or periodontal disease in adult and elderly patients. A recession will result in a darkening effect along the exposed implant crown. The unnatural and unesthetic shadowing effect on ceramic crowns is caused by stopped light reflection. In contrast, light reflection appears natural on teeth restored with thin enamel-bonded porcelain veneers.

The frequent lack of complete gingival papillary fill around implant crowns might also have esthetic consequences.^{10,11,29}

Bone loss on neighboring teeth was shown in an award-winning 10-year follow-up study of implant-supported crowns replacing maxillary incisors by Thilander et al.¹³ It is a progressive reduction of the interdental marginal bone level at the teeth adjacent to implants and was observed in some patients. The mean amounts of bone loss on the maxillary central incisors adjacent to implants were 3.2 mm (SD, 2.3 mm) after 3 years and 4.3 mm (SD, 2.7 mm) after 10 years.

The shorter the distance between the lateral incisor implant and the adjacent teeth, the greater the reduction of marginal bone levels on the neighboring teeth. Thus, it is unlikely that patients treated with space opening and prosthetic replacements will have better long-term treatment results than those treated with orthodontic space closure. The challenge is to develop a comprehensive treatment plan according to each patient's age, need, and diagnosis, preferably with an interdisciplinary team of specialists. An argument in favor of closure is that eventual complications with the noninvasive 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.

Despite objectively observed unesthetic complications, most implant patients apparently are satisfied with the outcome of their therapy.^{12,29} This is probably partly because it is difficult for patients to judge the esthetic result in relation to other treatment alternatives. Also, there seems to be a considerable discrepancy between professional evaluation and subjective patient opinion of dental appearance.^{12,29,35} Since present observation periods for implant-supported crowns only rarely exceed 10 years, time will show whether the differences between implant crowns and natural teeth will become even more pronounced in a longer time perspective.^{15,16} The question to be further clarified by controlled clinical studies in the future will be what serves our patients best in a life-long perspective, either using natural teeth in the esthetic zone or placing foreign bodies that will remain in place throughout the patient's lifetime.

PROFESSIONAL AND LAYPERSON PREFERENCES FOR SPACE CLOSURE OR OPENING

Recent studies by Ambruster et al^{21,22} tried to determine how general dentists ($n = 140$), orthodontists ($n = 43$), other dental specialists ($n = 29$), and laypeople ($n = 40$) judged the relative attractiveness of a series of photographs of teeth that included subjects with agenesis of the lateral incisors. The photographs included subjects with resin-bonded bridges, implants, and orthodontic space closures with canine substitution. Subjects with no missing teeth were used as controls. The results indicated that the lay population ranked photographs of the canines as lateral incisors as the best of all options. The orthodontists rated each category significantly different from each other in the following order from best to worst: no missing teeth, canines as lateral incisors, resin-bonded bridges, and implants. Compared with orthodontists, a significantly greater percentage of

general dentists and nonorthodontic dental specialists would restore the lateral incisors with implants and would do so primarily for esthetic reasons. Interestingly, however, for professionals who preferred restorative replacement, many did not rank any photograph of a restorative option as the best, and some of them responded that they would lateralize the canines on their own child (sic!).

CONCLUSIONS

A team approach combining carefully performed orthodontic space closure and esthetic porcelain veneers on several teeth will make it possible to treat patients with agenesis of at least 1 maxillary lateral incisor to a result that provides the look of an intact natural dentition (Figs 1 and 2). Advantages of such an approach are that (1) child patients will get the final result already as young teenagers, (2) the overall treatment can be completed after the orthodontic intervention, and (3) long-term adaptations of the teeth and supporting structures will appear natural.

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