

Maxillary Lateral Incisor Implants: The Orthodontic Perspective

Abstract: Implants are commonly used to replace congenitally missing lateral incisors in adolescent orthodontic patients. However, these restorations are often challenging for the orthodontist, surgeon, and restorative dentist. In some patients, the space across the alveolar crest is too narrow to permit the surgeon to place the implant. Occasionally the root apices of the adjacent central incisor and canine are in close proximity. In other cases the ridge thickness could be inadequate and require augmentation. When the orthodontist opens the space, the papilla heights are adversely affected. Some adolescent patients have altered passive eruption after orthodontic treatment that affects the level of the gingival margins. Finally, questions often arise regarding the appropriate age for implant placement in these young patients. If not addressed, these issues could compromise the esthetics of the implant restoration. This article will use several clinical examples to discuss each of these six potential problems and provide guidelines for their solutions.

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Learning Objectives

After reading this article, the reader should be able to:

- discuss the issues that could compromise the esthetic outcome of placing maxillary lateral incisor implants in the adolescent patient.
- describe how orthodontics can assist the surgeon and restorative dentist in improving the placement and esthetics of incisor implants.

Implants have become a common method for restoring missing teeth. After all, if an individual is missing teeth, but has no restorations or wear of their existing teeth, today it would be inappropriate to remove enamel and dentin to place crowns on adjacent teeth to facilitate the construction of a three-unit bridge. Implants are a much more conservative approach. This is especially true in the adolescent orthodontic patient who is congenitally missing one or two maxillary lateral incisors. If the treatment plan calls for opening the edentulous spaces, then implants would be an ideal alternative for replacing the missing teeth. Research has shown that the success rate of implants is very high;¹ however, maxillary lateral incisor implants are challenging esthetically. The amount of space is often small, the alveolar ridge may be deficient, the papillae are occasionally short, the adjacent roots could be too close, the gingival levels may be uneven, and the patient could be too young. Any of these issues could compromise the esthetic outcome of even the finest surgical implant placement. Orthodontics can assist the surgeon and restorative dentist to improve the esthetics of maxillary lateral incisor implants. This article will discuss six important issues that are necessary for

developing esthetic implants in the orthodontic patient who is congenitally missing their maxillary lateral incisors.

Adequate Implant Space

If a patient was congenitally missing one maxillary lateral incisor, the amount of space for an implant and crown would be determined by the contralateral lateral incisor. However, in some patients the existing lateral incisor may be peg-shaped. In other situations, both lateral incisors are congenitally absent. In the latter instance, what determines the amount of space for the implant and crown? The amount of space is determined by two factors: esthetics and occlusion.

An esthetic relationship exists between the size of the maxillary central and lateral incisors. The size relationship has been called the "golden proportion."² Ideally, the maxillary lateral incisor should be about two thirds the width of the central incisor.³ Because most central incisors are about 9 mm wide, the width of the lateral incisor space should be no less than 6 mm. Today, the narrowest implants are about 3.2 mm in diameter. If the edentulous space were 6 mm wide, then about 1.4 mm would exist between the implant and the adjacent roots. Previous studies have documented

implant and the adjacent root are more likely to show a reduction in bone height over time.^{4,5} So at least 1 mm between the implant and adjacent root is desirable.

However, in some situations the orthodontist may create less than the ideal width for a lateral incisor implant and crown because of the patient's occlusal relationships (Figure 1A through Figure 1D). The orthodontist should assess the posterior intercuspation as well as the appropriate amount of overbite and overjet. If the correct occlusion has been achieved, and the space for the implant crown is too narrow, the orthodontist should remove interproximal enamel from the central incisors and canines to provide additional width for the lateral incisor implant. In some cases, if the interproximal surfaces of the canines and central incisors are already flat, then the orthodontist must remove enamel interproximally from the premolars. The maxillary premolars generally have tapered crowns with sufficient thickness of enamel so they can be reduced without penetrating the dentin interproximally. By reducing the widths of adjacent anterior or posterior teeth, the orthodontist can create sufficient space for lateral incisor implants.

Space Between the Roots

Another area where space is an important issue is between the apices of the roots of the central incisor and canine. Generally, if space has been created for an implant by moving the central and canine crowns apart, the roots of these teeth may have tipped and moved into closer proximity (Figure 2A through Figure 2E). In the latter situation, there may be inadequate space to fit the implant between the apices of the central incisor and canine roots. During finishing the orthodontist must move the apices of these roots apart to provide adequate space for the surgeon to position the implant between the roots of these teeth. First, the orthodontist must take a progress panoramic or periapical radiograph. This will show the orthodontist which roots must be relocated. The tooth movement can be accom-

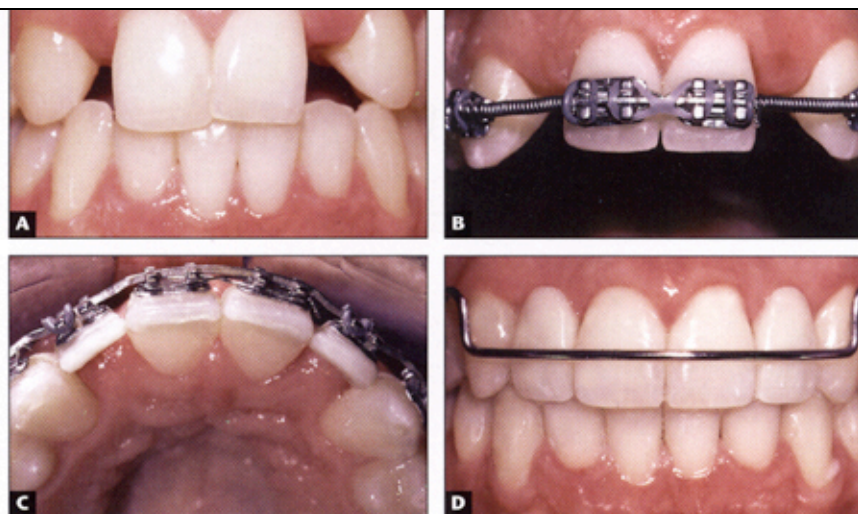


Figure 1—This patient had received orthodontic treatment to create space for lateral incisor implants, but for financial reasons implant placement had been delayed. Now the patient can afford implants, but the amount of space is 3 mm on the right and 4 mm on the left (A). Orthodontic treatment was re-initiated with the goal of creating more space for implants (B). However, the interproximal surfaces of the canines and central incisors were already flat; therefore, enamel was removed from the mesial and distal surfaces of the maxillary first and second premolars in order to create more space. The amount of space has been increased to 6 mm on each side. Plastic teeth on the archwire (C) and on her retainer (D) are now more proportional to the central incisors, and the occlusion still interdigitates properly.

plished either by repositioning the brackets on the teeth or by making appropriate bends in the orthodontic archwires. Either method will work, but the process takes time. It could require an extra 4 or 5 months to accomplish this type of root movement.

Many former orthodontic patients who were missing maxillary lateral incisors and were treated in the 1970s and 1980s may have been restored with Maryland or resin-bonded bridges. In these patients, it was not necessary to move the root apices apart. Therefore, many resin-bonded bridge patients will have roots in close proximity. Because resin-bonded bridges have an average life of only about 8 to 10 years before they require replacement,^{6,7} patients often will request replacement with implants. If the root apices are in close proximity, these patients will require orthodontics to correct their root angulation. However, the length of treatment is usually short, requiring only 4 to 6 months to correct the root angulation if the occlusion was established properly.

There could be another reason for root proximity after orthodontics. If a patient's orthodontic treatment was

completed at a young age, the patient could have significant facial growth remaining. As the maxilla and mandible grow, teeth erupt in response to the increase in vertical facial dimension. If the canine and central incisor roots were placed in an ideal position for implants at the end of orthodontics, the apices could migrate back toward one another in a patient who has significant vertical facial growth, compensatory eruption, and inadequate stabilization of the edentulous space. If patients are immature at the end of orthodontics and will have significant facial growth, it may be appropriate to place a bonded rather than a removable retainer in the lateral incisor edentulous space in order to prevent reapproximation of the central incisor and canine roots.

Implant Site Development

When the maxillary lateral incisor is congenitally absent, the permanent canine usually erupts adjacent to the central incisor. This is an ideal situation. As the canine is pushed distally to open space for the maxillary lateral incisor implant and crown, the root movement creates adequate alveolar

stretching the periodontal ligament. This process is called orthodontic site development. This process can be accomplished in any part of the alveolar ridge where a tooth will be moved before implant placement. But what happens to the buccolingual width of this bone over time?

That question was answered in a study that evaluated the long-term width of the alveolar ridge after space had been opened for missing maxillary

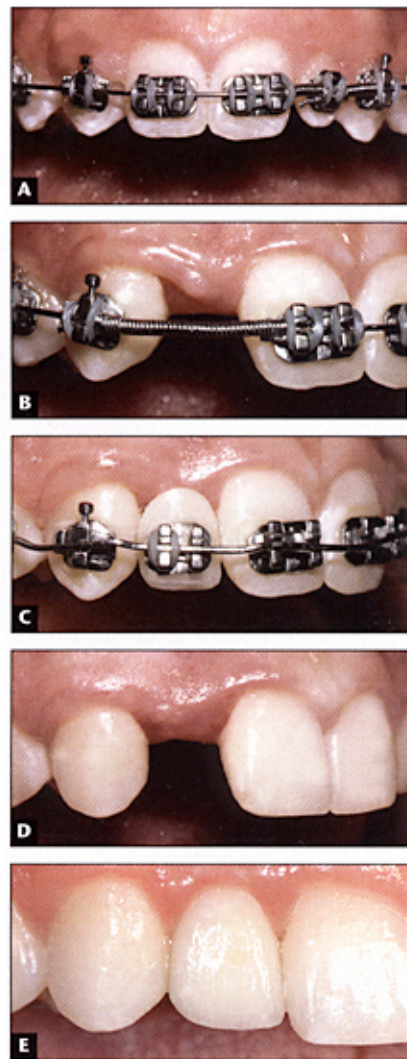


Figure 2—This patient was congenitally missing the maxillary right lateral incisor. After the maxillary arch had been aligned (A), no space was present for an implant. A coil spring (B) was used to open space. However, as the crowns moved apart, the roots of the canine and central incisor moved closer together. Therefore, the orthodontist placed tip-back bends in the archwire (C), in order to move the roots apart to create adequate space (D) for an implant. With sufficient space the restorative dentist can create ideal papillary esthetics adjacent to the implant crown that was stable after 5 years (E).

dentonic patients.⁸ The study sample consisted of 20 patients who were congenitally missing one or two maxillary lateral incisors. In all cases spaces were created for resin-bonded bridges. Dental casts were available at the end of orthodontic treatment and an average of 4 years after appliance removal. In addition, tomographs of the edentulous ridge were made at the 4-year recall. Maxillary dental casts also were sectioned across the edentulous ridge. Comparison of posttreatment and long-term measurements of the dental casts and tomographs revealed the amount of change that occurred across these edentulous ridges with time. The amount of bone loss in this sample was less than 1% over 4 years. Previous studies have shown that if maxillary anterior teeth are extracted, the alveolar ridge will narrow by 34% over a 5-year period.⁹ However, if the edentulous alveolar ridge has been created by orthodontic separation of two teeth, little resorptive change will occur over time.

Based on this information, the orthodontist should allow the permanent canines to erupt mesially when maxillary lateral incisors are congenitally absent. As the canines are moved distally, adequate alveolar ridge width will be established for future implants. Over time, this ridge will not resorb as readily as a ridge resorbs after tooth extraction.

There are several positive outcomes of having an excellent ridge for placing the implant. First of all, if the ridge width and height are ideal, then a bone graft will not be necessary. In these cases, it is not necessary to flap the area a second time to uncover the implant after it has integrated. The implant can be indexed before the flap is reapproximated. This will allow the surgeon to use a tissue punch to uncover the implant. In addition, the restorative dentist can have the provisional crown ready to place on the implant on the day of uncovering. These distinct advantages affect the appearance of the soft tissues around the implant and lead to a more esthetic implant restoration.

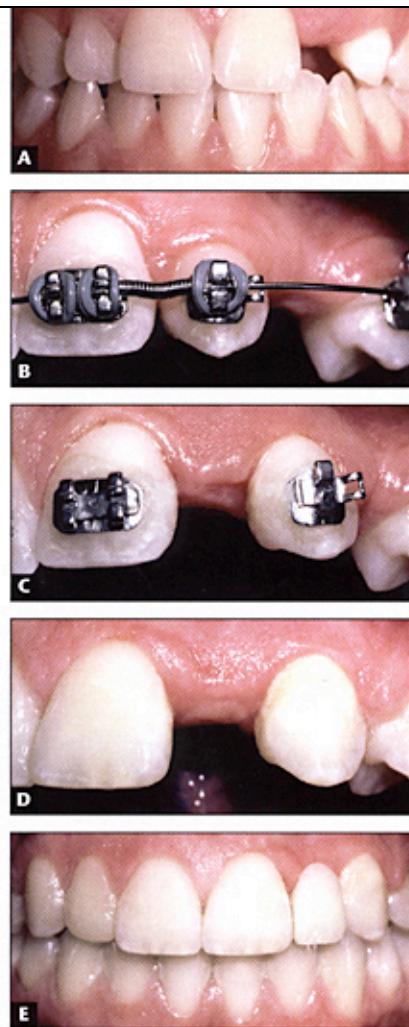


Figure 3—This patient was congenitally missing the maxillary left lateral incisor. The maxillary midline had not shifted, and the posterior occlusion was satisfactory (A). A coil spring was used to open space for the implant (B). As the space opened the papilla remained adjacent to the tooth that did not move (C). This phenomenon created a depression in the soft tissue at the mesial of the tooth that was moving. This depression is called Atherton's patch. Since this patient was young, growing, and erupting her teeth, Atherton's patch disappeared over time (D). When her retainer was placed, the papilla levels were even (E). If the papilla remains on the distal of the central incisor, it is easier to achieve a more esthetic result.

Correcting Loss of a Papilla During Space Opening

When the canine erupts adjacent to the maxillary central incisor, there is one papilla between these teeth. However, when space is opened for the missing lateral incisor, there must be two papillae created, (ie, one papilla on the distal of the central incisor and another papilla on the mesial of the canine). How does that happen? The

the age of the patient and the direction of the tooth movement.

If the patient is young and has sufficient growth potential, the formation of a papilla after orthodontic treatment is more predictable (Figure 3A through Figure 3E). However, if the patient is an adult, there will be no subsequent eruption of teeth after orthodontics. Lack of tooth eruption jeopardizes the formation of papillae after orthodontic space opening.

The direction of tooth movement directly influences the development of papillae after orthodontic space opening. As two teeth move apart, the

cent to the tooth that is not moving. If both teeth move apart equally, then the papilla will end up somewhere in the middle of the edentulous space. However, if the canine erupts mesially during facial growth and is pushed distally during orthodontics, the papilla will remain on the distal of the central incisor. As the canine is pushed distally, the mesial-gingival sulcus is stretched open, creating a red patch. This is called Atherton's Patch,¹⁰ and the color is red because it is lined with nonkeratinized sulcular epithelium. Over time, in a growing individual, this vertical defect will gradually disappear because of subsequent tooth eruption and redevelopment of a gingival sulcus that can be probed.

However, in adults, little or no tooth eruption occurs after orthodontic treatment. Therefore, if an Atherton's Patch is created after orthodontic treatment, it will not fill in, and, at the time of implant placement, it will seem that the orthodontics has somehow destroyed the papilla. Actually, this consequence is inevitable any time two teeth are pushed apart in a nongrowing patient. If an Atherton's Patch occurs on the mesial of the maxillary canine, then the esthetic compromise is less visible, because it affects a papilla that is positioned farther distally. However, if the orthodontic treatment involves moving the central incisor mesially in an adult patient, then an Atherton's Patch will appear on the distal of the central incisor. This will not improve in an adult implant patient, and will compromise the esthetic appearance after implant placement and restoration unless the appropriate surgical technique is selected.

In this situation, when the labial flap is elevated to place the implant, the mesial extension of the flap should extend to the mesial of the adjacent central incisor. This will allow the surgeon to undermine the flap and advance it coronally. When the implant is placed, a 2-mm healing cap is placed on the implant, and the flap is advanced over the healing cap. This draws the tissue coronally to recreate the papilla on the distal of the central incisor. Before the flap is advanced, the implant

restorative dentist can use a "punch" uncovering technique to uncover the implant after integration. Although there may be other methods of recreating a papilla, this technique predictably creates a papilla in an adult implant patient when an Atherton's Patch causes an esthetic compromise after orthodontic space opening.

Gingival Surgery for Altered Passive Eruption

At the end of orthodontic treatment, most adolescent patients are between the ages of 14 and 16 years old. As a result, their gingival margins may or may not be at an adult level relative to the cemento-enamel junctions (CEJs) of their anterior teeth. If an orthodontic patient is congenitally missing a maxillary lateral incisor, and the adjacent central incisor gingival margin is at its adult level, then the surgeon can use the central incisor as a guide for establishing the vertical position of the lateral incisor implant. However, if the central incisor gingival margin is not at its adult level, the surgeon must adjust for this discrepancy to avoid future problems with gingival margin discrepancies. This problem of gingival margin discrepancy is often called altered passive eruption. This description refers to the patient whose bone levels over the central incisors are about 2 mm from the CEJs, and/or the CEJs are at the bottom of the gingival sulci but the gingival margins are 3 mm to 4 mm coronal to the CEJs. If the patient has a normal or thick gingival type, then it could take several years for the gingival margins to migrate apically to establish a normal 1-mm sulcus.

If these patients are missing their lateral incisors and will have implants to replace these teeth, then altered passive eruption must be corrected before implant placement. In most implant systems, the future gingival margin of the lateral incisor crown determines the vertical position of the head of the implant (eg, the platform of the implant is placed 2 mm or 3 mm apical to the estimated gingival margin of the implant crown). However, the gingival margin of a lateral incisor must be

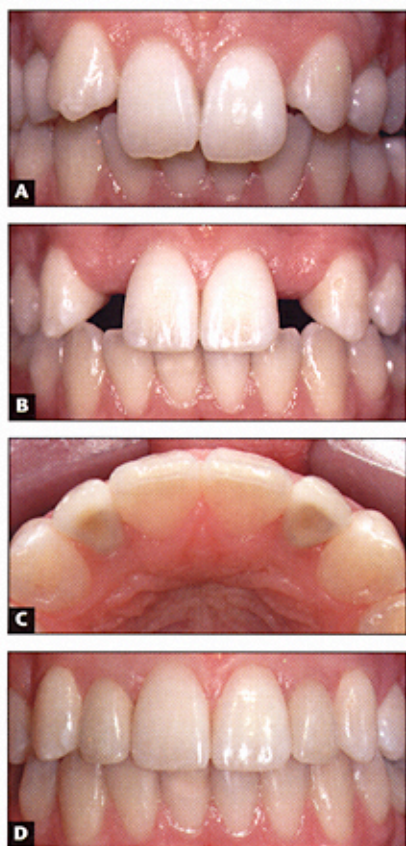


Figure 4—This patient was congenitally missing the maxillary right and left lateral incisors (A). Space was opened orthodontically for two lateral incisor implants (B). At the end of orthodontics, the gingival contour over the central incisors was scalloped, the sulcus depth was 1 mm, and the width-to-length proportions of the central incisor crowns were ideal. Because the vertical positioning of the head of the implant is based on the eventual gingival margins of the lateral incisor crowns, the gingival margins over the central incisors and canines must be stable. If so, when the implants are restored the relative gingival levels of the natural teeth and implants will be harmonious and appear natural (C and D).

to the adjacent central incisor and canine gingival margins. If the sulcular depth over the central incisor is 1 mm and the CEJ is located at the bottom of the gingival sulcus, then this relationship is normal and will not change significantly over time. Therefore, the surgeon can use the gingival margins of the central incisors as a guide for determining the correct positioning of the platform of the lateral incisor implant (Figure 4A through Figure 4D).

However, if the patient has altered passive eruption of the maxillary anterior teeth after orthodontic treatment, and the patient has completed facial growth, then the surgeon must first correct the gingival levels with gingivectomy before implant placement. This procedure will ensure that the eventual gingival margin over the maxillary lateral incisor implant will be at its correct level relative to the adjacent anterior teeth not only after restoration of the implant, but also long term after implant restoration.

Determining the Age of Implant Placement

Most orthodontic patients are about 14 to 15 years of age at the end of orthodontic treatment. If an adolescent boy completes his orthodontic treatment at 15 years of age, and a maxillary lateral incisor is congenitally absent, at what age can the implant be placed? If the implant were placed and restored too early, relative to the patient's tooth eruption, the reaction of the implant will be similar to that of an ankylosed tooth. The adjacent teeth may erupt and a discrepancy will be created between the gingival margins of the implant and the natural teeth. In a patient with a high lip line, this could be esthetically unacceptable. For these reasons patients must complete the majority of their tooth eruption before the placement of an implant.

Teeth erupt in response to growth. The question that the orthodontist must answer is whether or not the patient has completed the majority of their facial growth. A hand/wrist radiograph is inappropriate for assessing facial growth because it is not specific enough for each patient. The best

facial growth is by superimposing sequential cephalometric radiographs.¹¹ Most boys do not complete their facial growth until the late teenage years; a 14- or 15-year-old boy may not have gone through his adolescent growth spurt. It is advisable to wait until an adolescent boy has completed growth in height. At that point a cephalometric radiograph should be taken. Another radiograph should be taken at least 6 months to 1 year later. If these radiographs are superimposed, and there are no changes in vertical facial height (nasion to menton), then this indicates that most of the facial growth has been completed. If an implant were placed at that time, significant eruption of adjacent teeth would not be expected.

In some girls the growth of the face is often completed by 15 to 16 years of age. Therefore, it may be possible to place implants for congenitally missing lateral incisors earlier in girls without the risk of eruption of adjacent teeth. However, sequential cephalometric radiographs should be compared to verify that vertical facial growth has ceased.

When does growth cease in adolescents? A study was performed to determine the answer to that question.¹² The sample consisted of 150 boys and 150 girls who had completed orthodontic treatment. Lateral cephalometric radiographs were taken 10 years later on this sample. The ages of the sample allowed the cross-sectional data to be evaluated longitudinally. After statistical analysis, the average age at which facial growth stops in girls is about 17 years and in boys it is about 21 years of age. However, these ages are only averages. This information does not apply to any specific patient. The surgeon must evaluate superimposed cephalometric radiographs taken at least 1 year apart to verify that facial growth is complete.

Summary

This article has discussed six guidelines for managing adolescent orthodontic patients who are missing their maxillary lateral incisors and will require implants to replace these teeth. The space for the crown and implant, the space between the apices of the roots of the central incisor and canine,

the effect of space opening on the integrity of the adjacent papillae, the impact of altered passive eruption, and the method for determining the age of implant placement have been discussed in detail. The intent of this article has been to emphasize the importance of interdisciplinary decision-making when planning implants in young adolescent patients who are congenitally missing their maxillary lateral incisors.

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