

## Chapter 25

# MANAGING ORTHODONTIC-RESTORATIVE TREATMENT FOR THE ADOLESCENT PATIENT

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Most adolescent orthodontic patients have complete dentitions with few restorations, healthy periodontium, and lack of wear or trauma to their teeth. Therefore, orthodontists seldom need to interact with restorative dentists prior to or during orthodontic treatment. Some teenage orthodontic patients, however, have dental problems that require orthodontic-restorative interaction in order to produce an ideal functional and esthetic result.

Malformed maxillary lateral incisors, congenitally missing maxillary lateral incisors and mandibular second premolars, and major or minor trauma to the anterior teeth resulting in partial or complete fracture of permanent anterior teeth may require combined orthodontic, restorative, surgical, and periodontal intervention. As a result, orthodontists must know how to interact with other members of the dental team in the management of these types of problems. This chapter will use many examples to illustrate the key steps in managing the adolescent patient that requires orthodontic and restorative treatment.

### MALFORMED MAXILLARY INCISORS

The most common malformed tooth is the maxillary lateral incisor. It is often referred to as "pegged". These malformed laterals generally have two different shapes. Some are cone-shaped (Fig. 25-1), and others resemble the shape of a normal lateral incisor (Fig. 25-2), but are significantly narrower, thinner, and shorter. If a lateral incisor is only slightly narrower than normal, and the

problem is bilateral, the orthodontist may decide not to provide space to restore the tooth during orthodontic treatment. If the width discrepancy is only slight, the influence on the anterior occlusion, and the impact on esthetics may be indistinguishable. If the malformation is unilateral, however, or if the width discrepancy is significant, esthetics and occlusion could be affected adversely if the malformed tooth or teeth are ignored.<sup>1-5</sup>

Before the advent of composite bonding, restorative treatment of malformed maxillary lateral incisors was much more challenging and required a full-crown to enlarge the size of the malformed tooth. In an adolescent orthodontic patient with a large pulp chamber, however, the risk of irreversibly damaging the pulp is substantial if a full-crown were attempted. Bonding has permitted much more conservative restoration without extensive preparation of the lateral incisor. Either composite or porcelain veneer restorations, or complete composite or porcelain crowns may be bonded to the enamel with minimal tooth reduction. The orthodontist, however, must position the malformed tooth in the proper position in order to facilitate ideal restoration.

If the malformed lateral incisor is merely narrower, thinner, and shorter than the contralateral incisor, the final restoration probably will be a composite or porcelain veneer. In this situation, the orthodontist must position the tooth precisely prior to restoration. If sufficient space exists, a composite restoration may be placed before orthodontic treatment (Fig. 25-1). In most situations, however, there is insufficient space to restore the malformed lateral incisors (Fig. 25-2). Therefore, orthodontic treatment often is necessary to create space to build-up malformed lateral incisors.

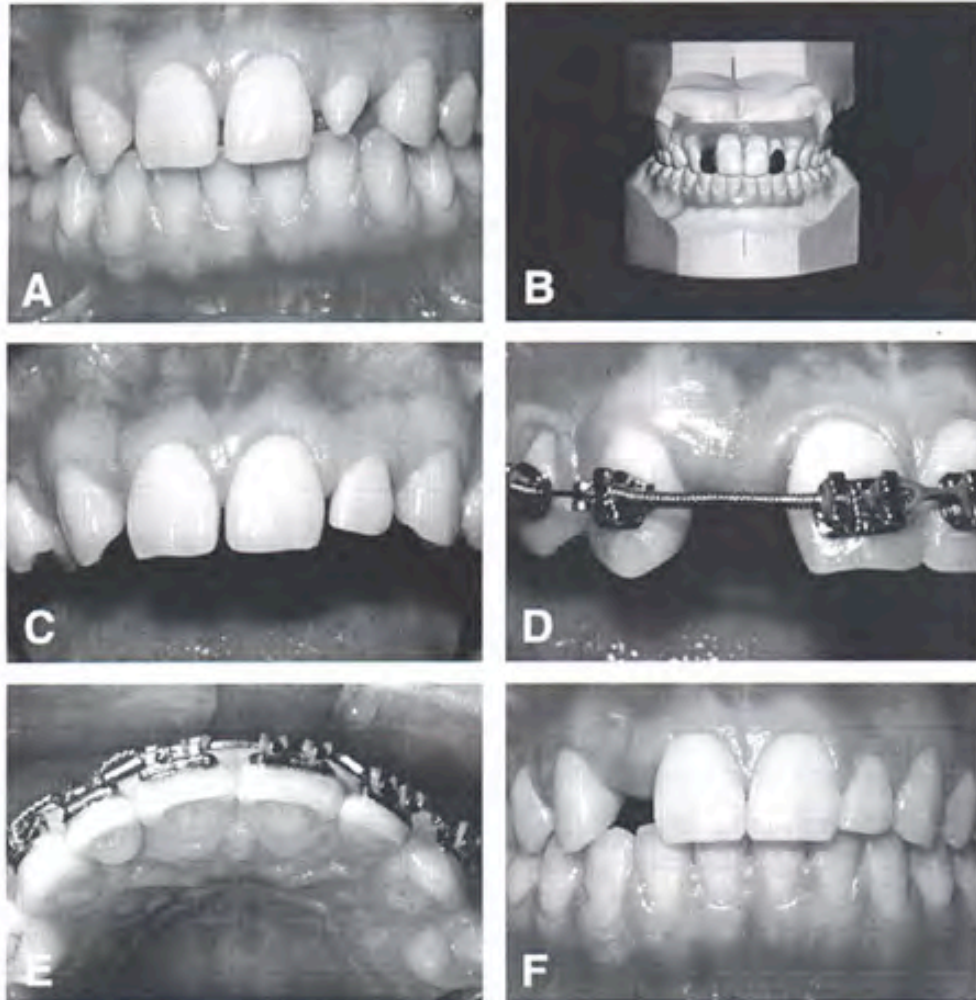


Figure 25-1. Restoration of a peg-shaped maxillary incisor. If the contralateral incisor is missing and sufficient space exists to restore the peg-shaped tooth (A), the restoration should be completed before orthodontic bracketing. The correct size of the lateral incisor restoration is determined by constructing a diagnostic wax set-up (B). The restorative dentist uses the set-up as a guide (C). Then during the orthodontic treatment, the orthodontist creates the same amount of space for the contralateral missing lateral (D,E,F). Relying on the diagnostic set-up will insure that the size of the laterals will be symmetrically identical and the teeth will occlude properly.

#### Creating a Space for a Restoration

The orthodontic mechanics to open space mesial and distal to the lateral incisor are relatively simple. Compressed coil springs are placed between the central incisor, lateral incisor, and canine to push the central and

canine away from the lateral incisor (Fig. 25-2C). Space will be generated in a few weeks. As space is created, four questions must be answered. First, how much space is required to restore the lateral incisor? If the patient is congenitally missing the opposite lateral incisor, a diagnostic wax-up should be constructed. This set-up will

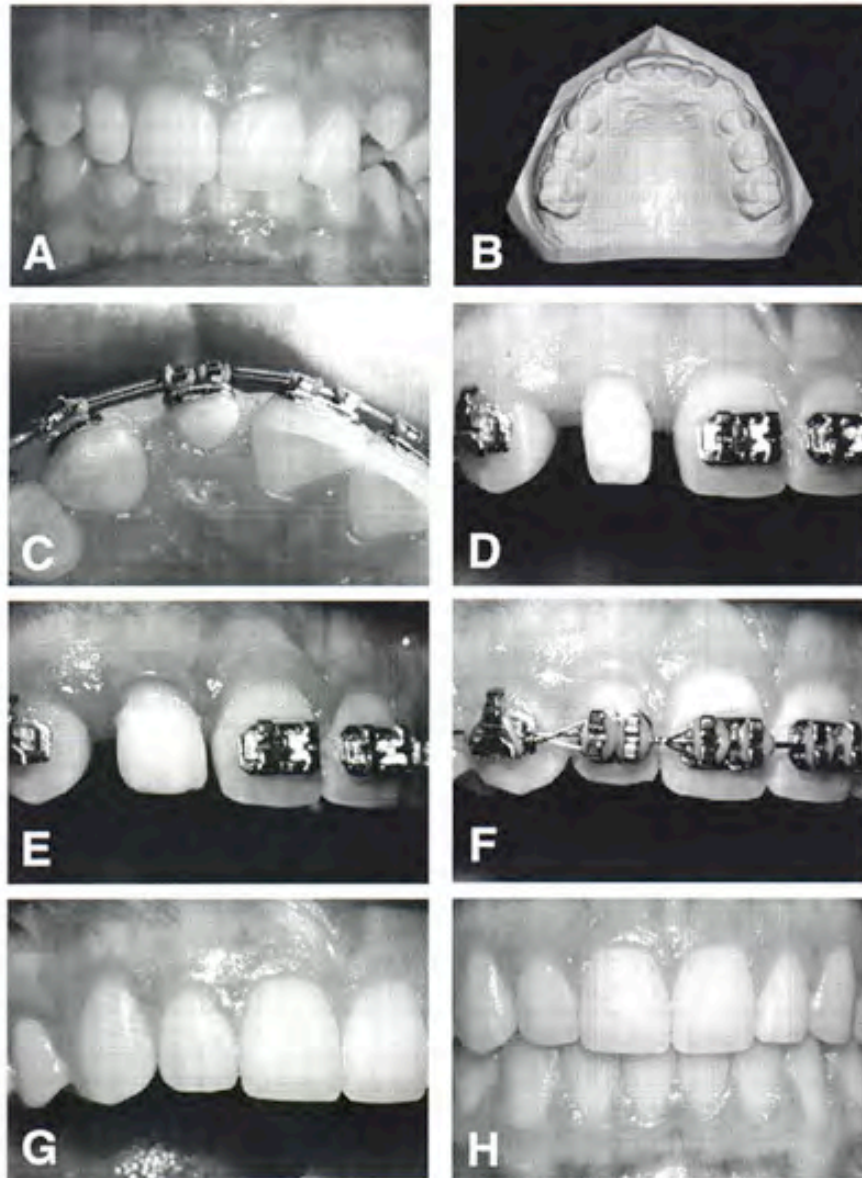


Figure 25-2. Restoration of a narrow maxillary lateral incisor. If one lateral incisor has normal proportions and the contralateral tooth is narrow (*A,B*), the narrower tooth should be restored to proper dimension during the orthodontic treatment. Compressed coil springs (*C*) are used to create space for the restoration. The narrow lateral is positioned nearer the central than the canine (*D*), so the form of the restoration can be flat on the mesial and overcontoured on the distal (*E*). This shape mimics the natural lateral incisor and allows creation of a more natural papilla between the central and lateral incisor (*F,G*). The gingival margin of the narrow lateral incisor is aligned with the gingival margin of the contralateral lateral incisor, so the eventual crown length, as well as the width, will be identical to the natural lateral incisor (*H*).



determine the correct size for the restoration of the peg-shaped lateral incisor (Fig. 25-1). If the patient has an existing lateral incisor of normal width on the opposite side, it is appropriate to create the same amount of space. Occasionally, it is advantageous to create extra space temporarily (Fig. 25-2C). This additional space will allow the restorative dentist to contour and polish the interproximal surfaces of the temporary composite restoration, so it matches the width of the opposite lateral. Any residual space may be closed after the restoration has been placed (Fig. 25-2).

When creating space orthodontically, a second question arises. Where should the maxillary lateral incisor be positioned mesiodistally relative to the central incisor and canine? If the lateral incisor is positioned too close to the canine, the mesial surface of the lateral must be overcontoured to achieve the appropriate crown width; the result could be unesthetic. The emergence profile or contour of the mesial surfaces of lateral and central incisors is relatively flat. The distal surfaces of central and lateral incisors are more contoured or convex. Therefore, the peg-shaped lateral incisor should be positioned nearer the central incisor<sup>5</sup> than the canine during orthodontic treatment (Fig. 25-2C).

Where should lateral incisor be positioned buccolingually: toward the labial, in the center of the ridge, or toward the lingual? The answer to this question depends on the type of permanent restoration that eventually will be constructed for the tooth. In most instances during orthodontic treatment, a temporary composite build up is placed on a peg-shaped lateral incisor. Eventually, this tooth may be restored with either a porcelain veneer or a porcelain crown. If the eventual restoration will be a porcelain crown, the lateral incisor should be positioned in the center of the ridge buccolingually, leaving 0.50 to 0.75 mm of overjet. Positioning the tooth in this manner will avoid additional tooth preparation of the lingual of the lateral and permit space for gold and/or porcelain in the final restoration. If the final restoration will be a porcelain veneer, however, then the peg-shaped lateral should be positioned lingually to contact the mandibular incisors in centric occlusion.<sup>7</sup> Sufficient space will be available on the labial to construct both the temporary composite build-up and the eventual porcelain veneer.

Finally, where should the lateral incisor be positioned incisogingivally? This relationship is determined by the relative positions of the gingival margins (Fig. 25-2F). Most peg-shaped lateral incisors not only are narrower mesiodistally and buccolingually; they also are shorter than normal lateral incisors incisogingivally. If the incisal edge is aligned with the opposite lateral incisor, the crown could be too short. Therefore, the gingival mar-

gins of the peg-shaped lateral should be aligned with the contralateral lateral incisor.<sup>2</sup> The restorative dentist will restore proper length, width, and thickness of the tooth, when the temporary composite build-up and final restoration are constructed.

### Gingival Surgery Prior To Restoration

In some adolescent patients, the clinical crown length of the malformed lateral incisor may appear unusually short (Fig. 25-3A). This situation could affect the ability of the restorative dentist to build-up the tooth, and the restoration may not accurately represent the true anatomical crown length. If the malformed lateral incisor is short, the orthodontist should take a periapical radiograph of the tooth to determine the actual position of the cementoenamel junction (Fig. 25-3B). Many of these situations require gingival surgery<sup>6</sup> to lengthen the malformed incisor crown (Fig. 25-3C) prior to restoration (Fig. 25-3D). In most instances, the surgery will involve simple excisional removal of gingiva. The orthodontist may confirm the need for crown lengthening by probing the sulcus around the lateral incisor to determine if the sulcular depth is greater than one millimeter on the labial surface. In some situations, if the alveolar bone level is near the cementoenamel junction and the zone of gingiva is narrow, the surgery could be more involved and require an apically positioned flap and bone removal to achieve the proper crown length. Creating proper crown length facilitates the construction of the provisional restoration and enhances placement of orthodontic brackets on the peg-shaped tooth (Fig. 25-3DEF).

### MULTIPLE MALFORMED INCISORS

Occasionally, both central and lateral incisors may be malformed and narrower than normal (Fig. 25-4). This abnormal morphology will create a substantial anterior tooth-size discrepancy and a compromised esthetic result if the teeth are not restored to a larger size at some time either before or during the orthodontic treatment. If centrals and laterals are malformed bilaterally, there are no guides for the correct size of these teeth. This situation is complicated further if the patient has a significant posterior malocclusion (Fig. 25-4AB). In these patients, it is mandatory that the orthodontist create a diagnostic wax set-up (Fig. 25-4E) prior to restoration to simulate the correct size of the centrals and laterals in order to provide not only the correct anterior and posterior occlusal relationship (Fig. 25-4FG), but also to provide the correct esthetic balance between the widths of the central and lateral incisors (Fig. 25-4HH).

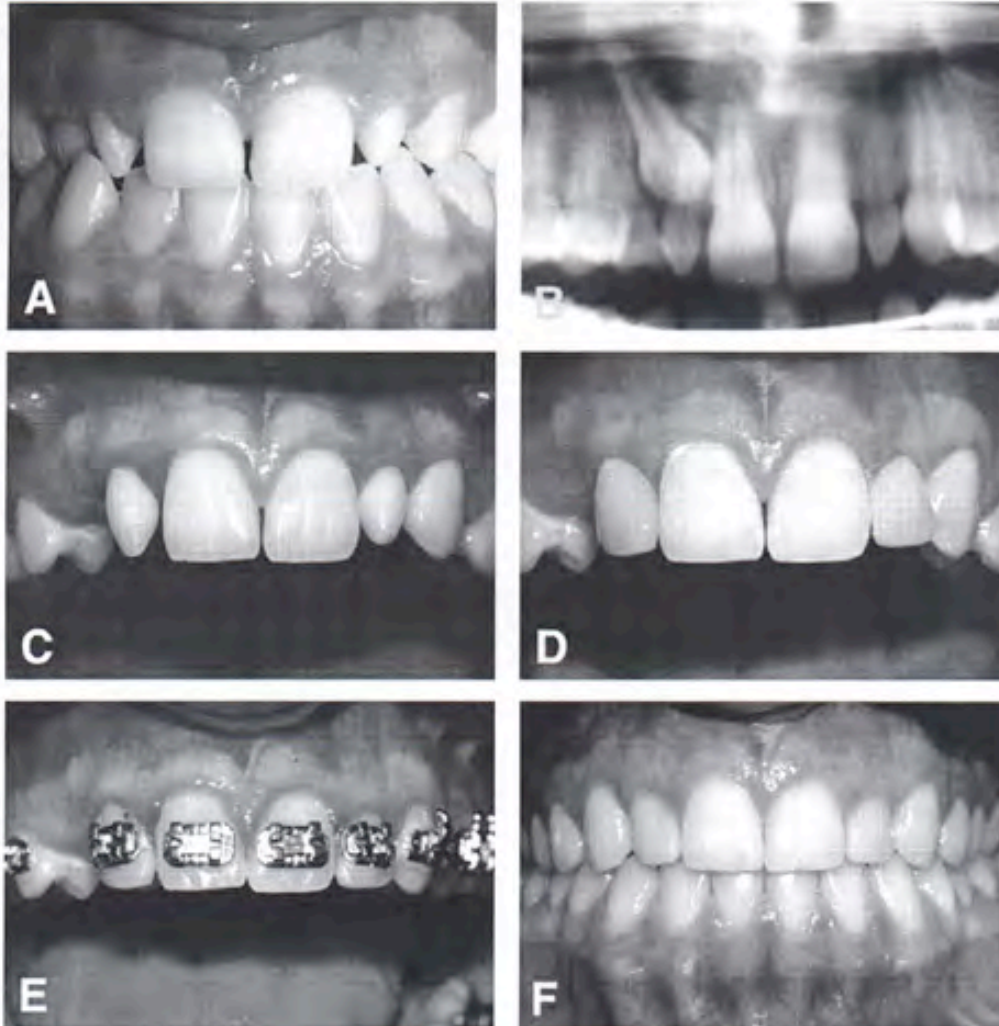


Figure 25-3. Restoration of bilateral peg-shaped lateral incisors. If both maxillary lateral incisors are peg-shaped (*A*), and the canine is impacted in the palate (*B*), an accurate diagnostic wax set-up to determine the appropriate size of lateral incisor restorations may be inaccurate. In addition, the peg-shaped laterals may not be completely erupted, making restoration difficult. In these situations, gingival surgery to lengthen the clinical crowns (*C*) is beneficial. The size of the lateral incisor restoration is estimated from the width of the central incisor, and should be about two-thirds the width of the central (*D*). By restoring the lateral incisors in this way, orthodontic bracketing (*E*) is much easier, the esthetic result is improved, and the occlusion fits properly (*F*).

### CONGENITALLY MISSING MANDIBULAR SECOND PREMOLARS

Often adolescent patients are congenitally missing mandibular second premolars. The options for replacing

these teeth depend on several factors. First of all, the clinician must decide if the patient has an arch length deficiency. If so, and the patient's profile will not be adversely affected, extraction of maxillary premolars and mandibular primary second molars along with complete space closure may be the best alternative to eliminate

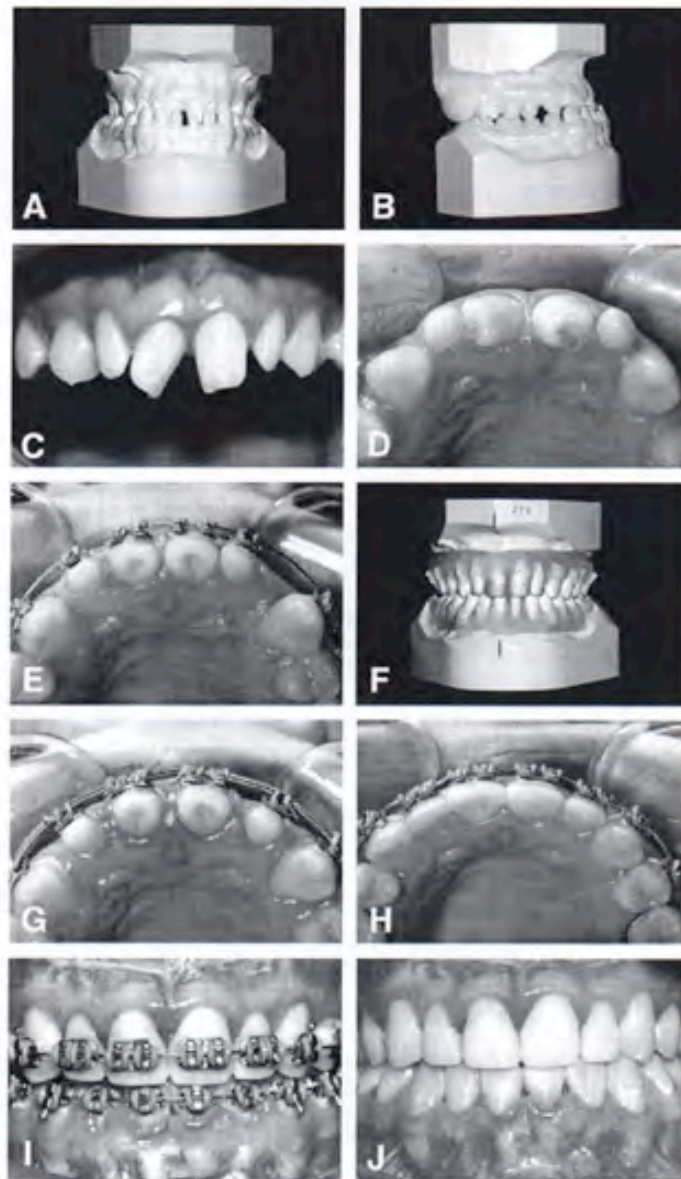


Figure 25-4. Restoration of multiple malformed maxillary incisors. Occasionally, both the maxillary central and lateral incisors are narrow. If the patient has a skeletal malrelationship (*A, B*), it may be difficult to estimate the correct width for restoration of the malformed incisors (*C, D*). In these situations, creating the correct spacing during orthodontic treatment (*E*), is determined by constructing a diagnostic wax set-up that simulates the result of both the orthodontics and orthognathic surgery (*F*). The set-up is used by the orthodontist to open interproximal spaces (*G*) and by the restorative dentist to restore the malformed incisors to their proper width during orthodontics (*H*). If the set-up is accurate, the orthognathic surgery will produce the correct anterior and posterior occlusion (*I*) as well as the appropriate esthetic relationship of the maxillary incisors (*J*).



the need for restorations. Alternatively, if the arch length deficiency is not severe, or if the patient has a satisfactory profile, extraction of teeth and space closure may be disadvantageous. In these situations, the space from the congenitally missing premolars must be maintained and restored with either a bridge or an implant.

### Retaining Primary Molars

If an implant is planned for the congenitally missing mandibular second premolar, the space and bone support must be monitored and maintained. It is ideal to allow the mandibular primary molar to remain in position as long as possible in order to maintain the bone support. However, the primary molar may be too wide (mesiodistally) to occlude properly with the opposing dentition (Fig. 25-5AB). In this situation, it may be advantageous to reduce the width of the primary molar<sup>7</sup> so it approximates the width of a second premolar (Fig. 25-5CD).

The reduction can be performed efficiently with a fissure bur. It is important for the clinician first to determine the width of the primary molar at the cervical region. By examining a bitewing radiograph, the clinician can estimate the width of the primary molar. Then that distance is transferred to the occlusal table of the primary molar, and a thin fissure bur should be used to reduce its width. Usually local anesthetic is not necessary, because this type of procedure typically is performed around age 14 to 15 years, when the pulp chamber of the primary molar has constricted significantly.

After the width of the molar has been reduced, it is advantageous to cover the exposed dentin on the mesial and distal surfaces by means of a light-cured composite (Fig. 25-5E). Then the composite restoration may be trimmed to simulate the shape and size of a mandibular premolar. In this way, the primary molar may be bracketed (Fig. 25-5FG) and remain in position to maintain the alveolar bone prior to implant placement (Fig. 25-5H).

### Timing Primary Tooth Extraction

If the primary molar has remained in position for several years, and the patient chooses to have the implant placed, then the primary tooth must be removed prior to implant placement. The implant should be placed about two months after the primary tooth extraction to allow for soft tissue healing over the extraction socket, but avoid narrowing of the edentulous ridge (Fig. 25-6).

### Extracting Ankylosed Primary Molars

Occasionally, the mandibular primary second molar will become ankylosed (Fig. 25-7) and fused to the alveolus. In these situations, leaving the primary molar may result in a significant bone defect in the edentulous ridge (Fig. 25-7). If an implant is planned in the edentulous site, the vertical defect may be difficult to implant. The decision to extract an ankylosed primary molar depends on the patient's age and gender.<sup>7</sup> If the second premolar is congenitally missing, and the primary molar is ankylosed and submerging at ages 7 through 12 in either males or females, the ankylosed tooth should be extracted. At these ages in both genders, the patient has considerable facial growth remaining. As the mandibular ramus grows, the posterior teeth will erupt, except in the ankylosed site. This condition eventually will cause a vertical alveolar defect. However, if the ankylosed tooth is extracted, however, research<sup>8</sup> has shown that the alveolar ridge will move occlusally with the adjacent teeth as they continue to erupt (Fig. 25-8). The stretching of the periosteum over the ridge provides the osteoblastic activity to continue alveolar ridge growth.

If the patient is a male aged 12 to 15, the ankylosed and submerging primary molar also should be extracted, as males may have significant mandibular ramus growth until the late teenage years. In contrast, females generally complete facial growth earlier, and an ankylosed primary second molar may not be submerging after 13 years of age in females, thus not creating a vertical alveolar defect.<sup>7</sup> In general, it always is advantageous to maintain the mandibular primary second molar, but reduce its mesiodistal dimension, in order to preserve the width of the alveolus for the future implant. The primary second molar should only be extracted if it is submerging.

### Determining The Age For Implant Placement

The age for implant placement in adolescent males and females is completely dependent on the completion of facial growth.<sup>7</sup> As the mandibular ramus continues to grow, the posterior teeth erupt. If an implant is placed too early, before growth is completed, it will mimic an ankylosed tooth and become submerged in the alveolus. This situation could lead to a periodontal defect between the implant and adjacent teeth, if the defect is severe enough.

The most precise method for determining if facial or ramal growth is completed is to superimpose sequential cephalometric radiographs. If growth is continuing, the

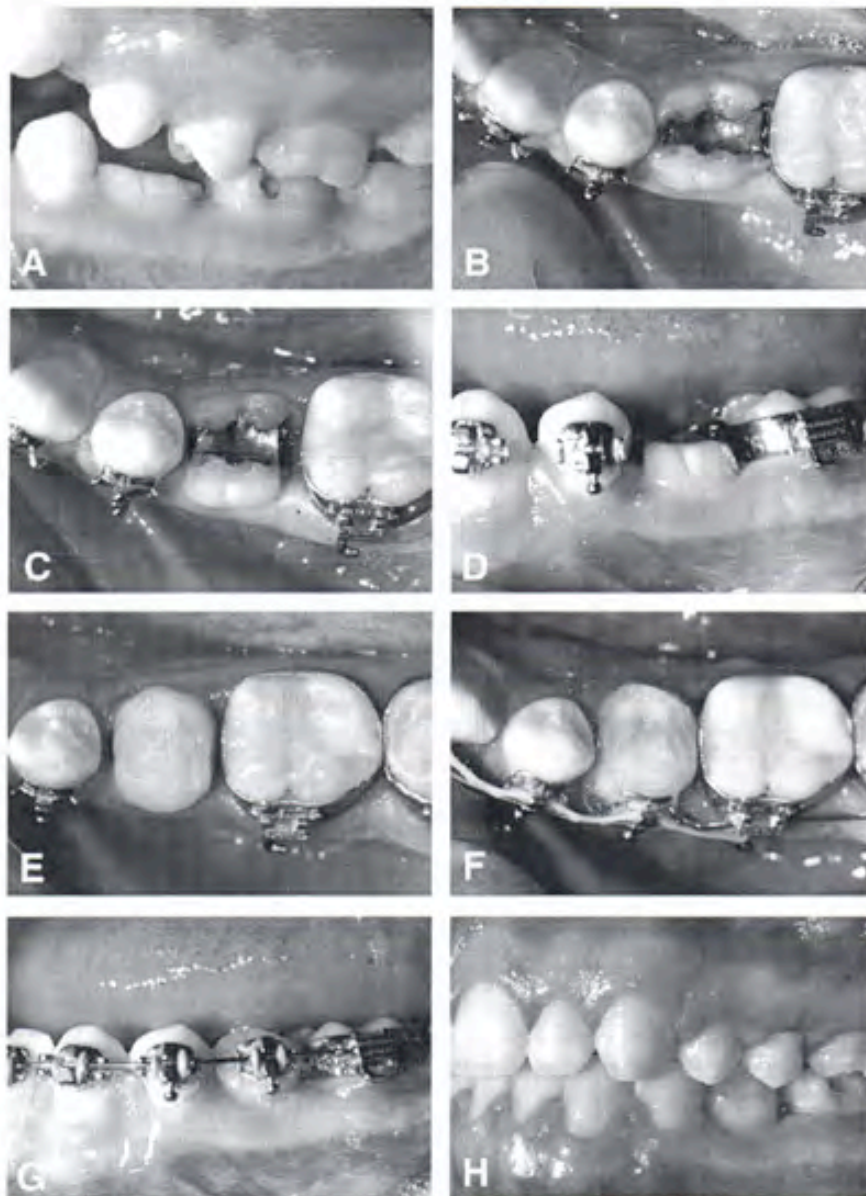


Figure 25-5. Reshaping and restoring primary mandibular second molars. If the mandibular second premolar is congenitally absent, it is advantageous to retain the primary second molar in order to preserve the width of the alveolar ridge for eventual implant placement (*A,B*). In these situations it is helpful to reduce the width of the primary molar (*C*), to produce the correct posterior occlusion. To facilitate orthodontic bracketing of the primary molar, it is necessary to restore it temporarily with composite (*D,E*). Then the spaces can be closed (*F,G*), and the resulting occlusion will improved (*H*). The primary molar not only retains the correct amount of space for the eventual implant, but prevents overeruption of teeth in the opposing arch (*H*), until the implant is placed.



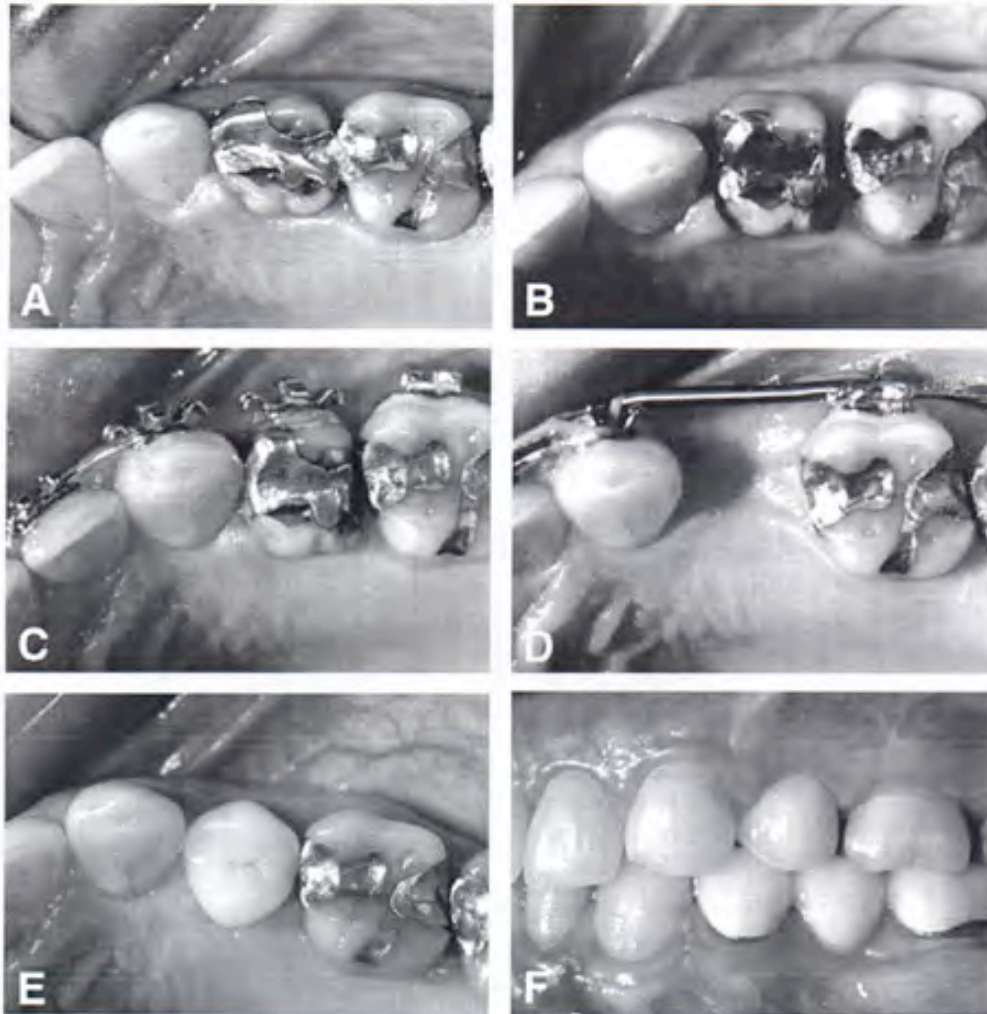


Figure 25-6. Timing extraction of primary molars before implant placement. Eventually retained primary molars will be extracted to facilitate placement of implants. If primary teeth are extracted too early, however, the alveolar ridge will narrow significantly and may complicate implant placement. In this patient, both maxillary premolars were congenitally missing, and the primary second molar had been retained (A). The width of the primary tooth was reduced (B), and the excess space was consolidated orthodontically to produce the correct width for a premolar implant crown (C). The primary tooth was extracted six weeks prior to implant placement to preserve the width of the alveolar ridge (D). By retaining the primary molar, the final maxillary premolar crown has the appropriate esthetic dimension, and the posterior occlusion fits properly (E,F).

distance between nasion and menton will continue to increase, indicating that it is too early to place the implant. The implant should not be placed until there is no change in facial vertical dimension taken on two headfilms one year apart. In general, implants should not be placed in boys until after 21 years of age, and in females until after 17 years of age.

#### Other Restorative Options

The other option for replacing a congenitally missing mandibular second premolar is preserving the space and placing a conventional full-coverage bridge or a resin-bonded bridge. Neither of these options, however, is desirable in young patients. First of all, most adolescent

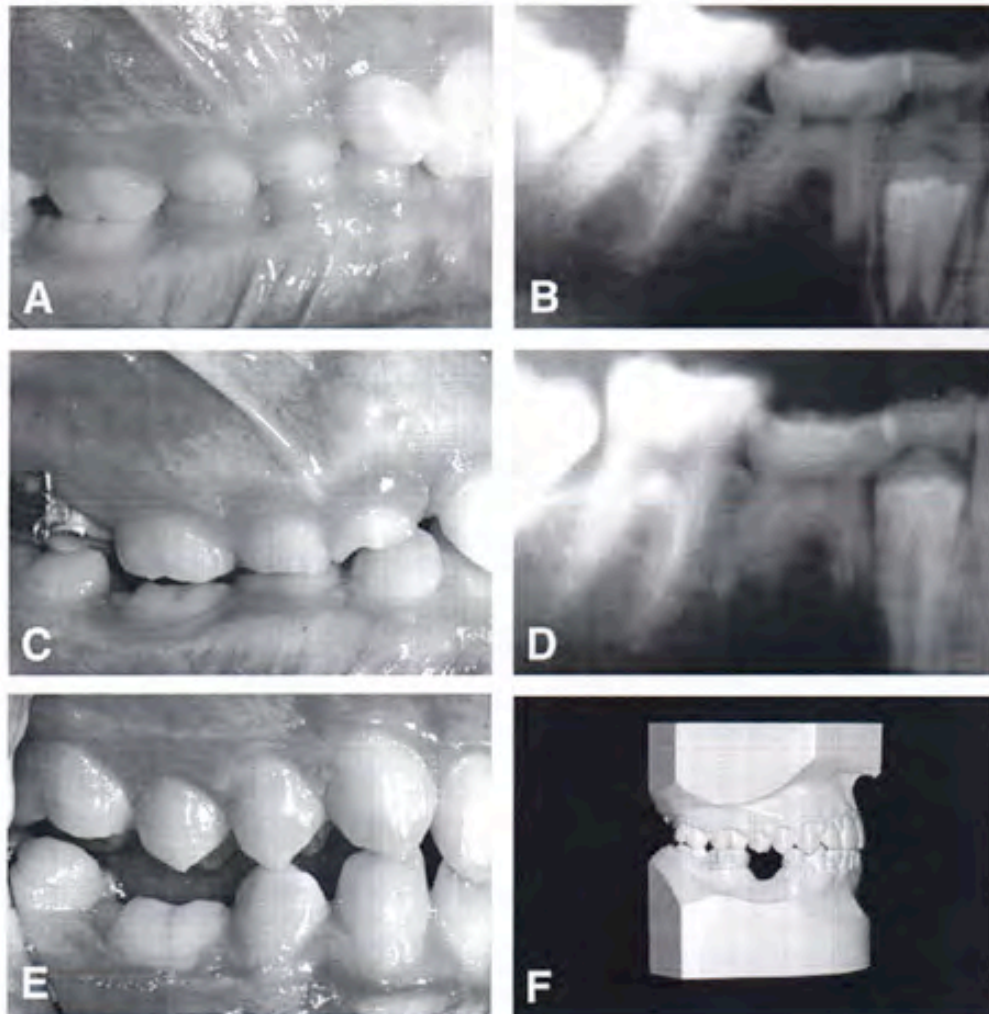


Figure 25-7. Timing extraction of primary second molars to facilitate implant placement. If mandibular second premolars are congenitally missing, an ankylosed primary molar must be extracted at the appropriate time to avoid alveolar ridge deformation. This patient was initially examined at 9 years of age (A,B), and was treated with a headgear and maxillary incisor brackets for one year. At age 10 years (C,D), the mandibular primary molar was submerged, the alveolar crestal bone level was angled obliquely between the permanent and primary molars, but the ankylosed tooth was left in place. At 14 years of age (E), a second phase of orthodontic treatment was begun. However, the primary molar was not removed until after orthodontic therapy had been completed, at 16 years of age (F). As a result the alveolar ridge has a severe vertical defect that would make implant placement extremely challenging and likely require a bone graft.

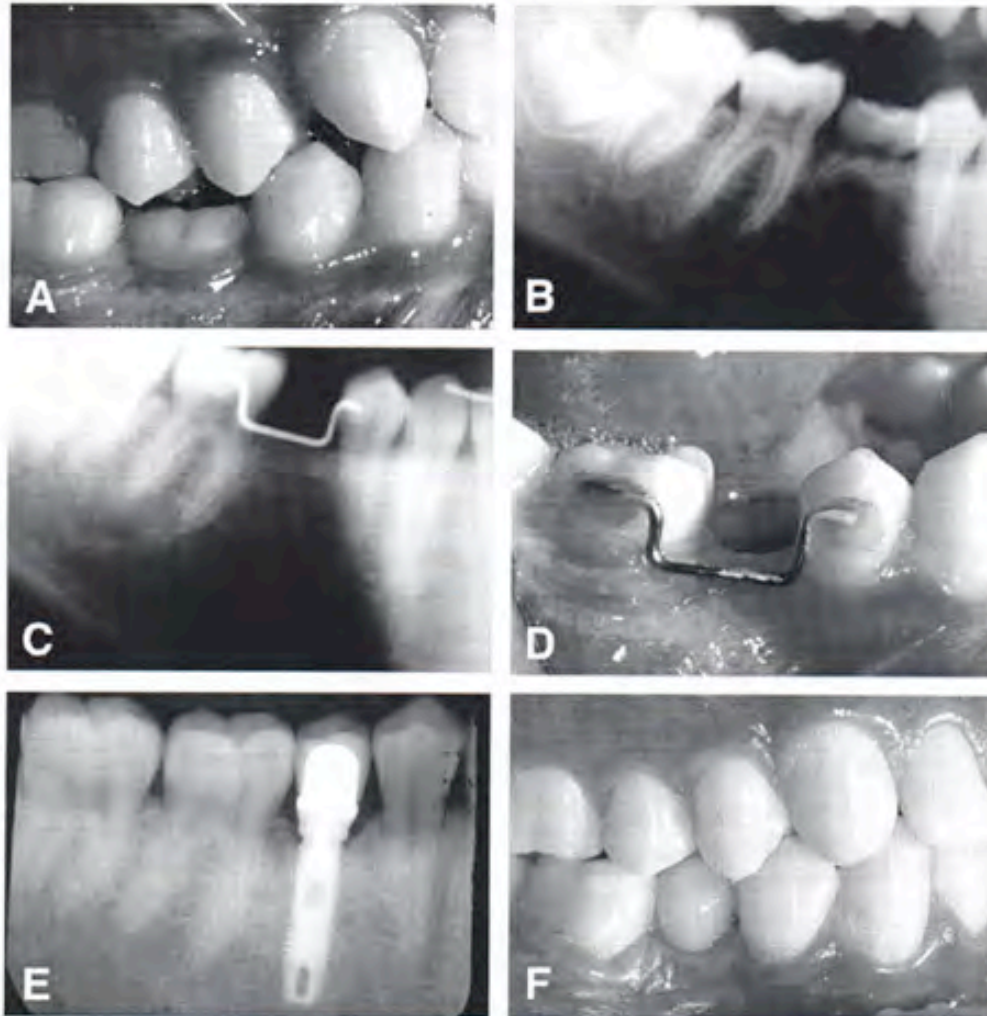


Figure 25-8. Effect of early extraction of an ankylosed primary molar. In this patient, the mandibular right second premolar was congenitally absent, and the primary molar was retained, ankylosed, and submerging (*A,B*). In order to avoid ridge deformation, the primary molar was extracted prior to orthodontic treatment. After the completion of orthodontics, the radiograph (*C*) shows that the edentulous alveolar ridge moved coronally as the adjacent premolar and molar erupted (*D*). This produced the appropriate vertical position of the alveolar ridge to facilitate implant placement (*E*) and restoration (*F*).

patients do not have caries in the first premolar or first molar. Therefore, it is destructive to prepare these teeth for full crowns simply to replace a missing second premolar. Resin-bonded bridges generally do not have a high success rate in the posterior quadrant, especially in the mandibular arch.<sup>9,10</sup> Posterior resin-bonded bridges require frequent re-bonding.

#### Orthodontic Development Of The Implant Site

If an ankylosed primary molar is not extracted early enough, and a vertical ridge defect is produced, another option is to move the mandibular first premolar into the second premolar position<sup>7</sup> and to place the implant in



the first premolar position (Fig. 25-9). Previous studies have shown that it is possible, within limits, to move a tooth into a narrower edentulous ridge<sup>11,12</sup> in order to create an implant site. The bone that is created behind the moving tooth typically will be the width of the root of the tooth that was moved. This type of orthodontic movement, termed "orthodontic implant site development," may eliminate the need for a bone graft in the edentulous site.

## CONGENITALLY MISSING MAXILLARY LATERAL INCISORS

### Indications For Canine Substitution

Many orthodontic patients are congenitally missing their maxillary lateral incisors. If this problem occurs, there are two general options for treatment. One option involves opening space for a pontic or implant, and the other option involves substitution of maxillary canines for lateral incisors and closure of the maxillary edentulous spaces (Fig. 25-10). Three criteria should be evaluated before choosing this treatment option. First of all, the patient's occlusion or malocclusion must be appropriate. The ideal situation for canine substitution is a patient with a Class II molar relationship, minimal crowding of the mandibular teeth, and an acceptable facial profile. Substitution of the permanent canines for the lateral incisors will eliminate the need for any major restorations.

The second criterion for selecting canine substitution is the anterior tooth-size relationship. When canines are substituted for lateral incisors, maxillary anterior tooth-size excess is created. The widths of the maxillary six anterior teeth often must be reduced in size to create the correct overbite and overjet relationships. A diagnostic wax set-up is necessary to determine if canine substitution is a reasonable treatment plan for congenitally missing lateral incisors.

The third criterion is the length, shape, and color of the maxillary canine crowns. If canines are substituted for lateral incisors, their gingival margins must be positioned more incisally relative to the central incisors, because the crown lengths of lateral incisors are typically shorter than central incisors. Therefore, the canines must be erupted, and their cusps must be equilibrated to create the illusion that they are lateral incisors (Fig. 25-10). If the shape of the canine cusp is unusually long and pointed, it could be impossible to reduce the cusp enough to simulate the incisal edge of a lateral incisor.

One of the most difficult aspects of canine shape to

overcome is the labial contour. Some maxillary canines have relatively flat labial surfaces. This type of contour more closely resembles the labial contour of a lateral incisor. However, some maxillary canines have convex or rounded labial surfaces. It is challenging to make these teeth look like laterals because of the rounded labial contour. Restoration of the labial surface with a porcelain or composite veneer will create a much more acceptable esthetic result.

### Esthetic Crown Lengthening

A common esthetic problem with maxillary canine substitution is the gingival discrepancy between the canine and first premolar (Fig. 25-11). If a canine is substituted for a lateral incisor, the premolar is located in the maxillary canine position. In this situation, the premolar may appear too short compared to the canine. Crown lengthening of the premolar by gingival surgery may create a better relationship between the gingival levels of the maxillary anterior teeth and also enhance anterior esthetics.

### Positioning Teeth For Resin-Bonded Bridges

A second option for congenitally missing lateral incisors is maxillary resin-bonded or Maryland bridge. These restorations typically are easy to construct if the orthodontist positions the central incisor and canine in their proper relationships (Fig. 25-12). First, the angulation of the central incisors should be more upright and vertically oriented.<sup>2</sup> In this position, the occlusal force through the crown of the central incisor produces a shear force at the restoration-tooth interface.

A second important aspect of tooth position for the resin-bonded bridge is the amount of overbite. Typically, the amount of overbite in any orthodontic patient should be determined by evaluating protrusive function of the mandible. The amount of overbite is sufficient when the posterior teeth disclude as the mandible is protruded in an end-to-end incisor relationship. In a patient with an anterior resin-bonded bridge, however, the amount of overbite is even more critical. If the overjet is zero with the maxillary and mandibular incisors in contact, then minimal space is present for the bonded metal connector of the resin-bonded bridge. Therefore, in a patient with a resin-bonded bridge, the clinician should create minimal overbite,<sup>2</sup> with just enough overlap to provide disclusion of the posterior teeth in protrusive function (Fig. 25-12).

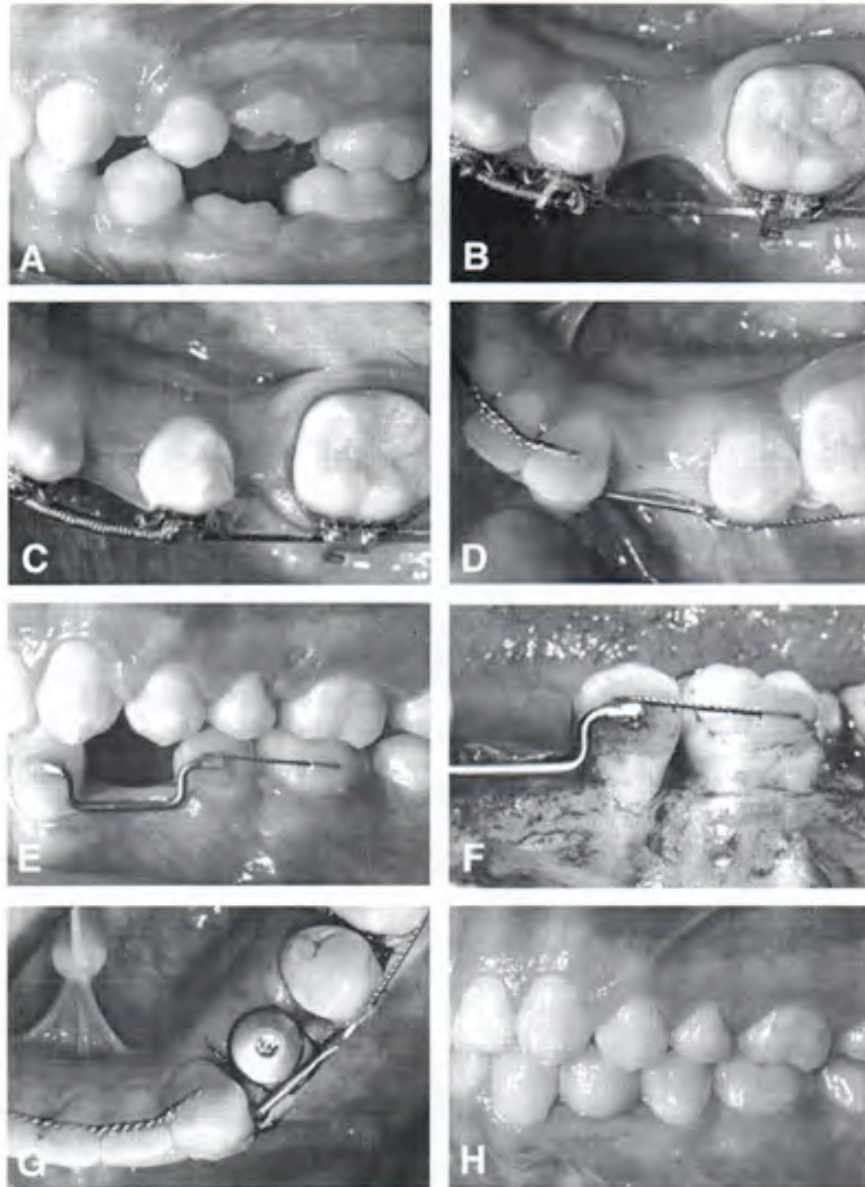


Figure 25-9. Orthodontic implant site development. In this patient, the mandibular left primary second premolar was congenitally absent, and the mandibular left primary second molar was ankylosed and submerged (A). After extraction of the primary second molar, the alveolar ridge resorbed significantly (B), and jeopardized implant placement. In order to create the appropriate width of bone for an implant and avoid bone grafting, the first premolar was pushed distally (C) into the second premolar position (D,E). When the surgery was performed to place the implant, the bone distal to the first premolar did not show any dehiscence (F). By moving the first premolar distally, the implant site was created mesial to the first premolar, and permitted placement (G) and restoration (H) of the implant without bone grafting.



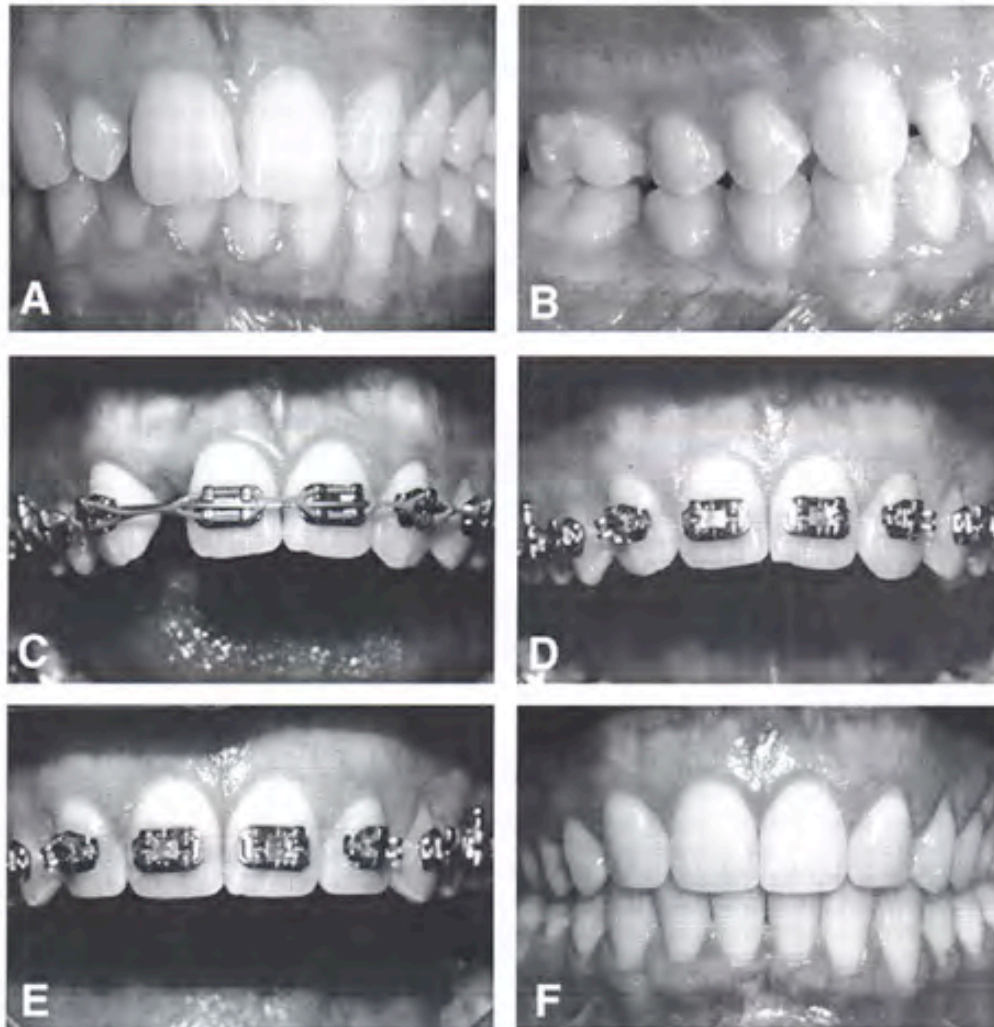


Figure 25-10. Canine substitution. Occasionally, canine substitution may be the best option for treating a patient with a congenitally missing maxillary lateral incisor. However, certain criteria should be evaluated before choosing this option. In this patient, the maxillary left lateral incisor was congenitally absent, and the right lateral was peg-shaped (*A*). The molar relationship was Angle class II (*B*), and the patient had a good facial profile. In addition the size, shape, and color of the maxillary canines were acceptable. Therefore, the right lateral was extracted (*C*), and the space was closed (*D*). The maxillary canines were extruded (*D*), and the cusps were equilibrated (*E*) to simulate the length and shape of lateral incisors. The final orthodontic result (*F*) shows a reasonably good proportion of size between the canine and central, and the shape tends to simulate a lateral incisor. This plan, if appropriate, is advantageous, because it obviates the need for an implant or bridge.

#### Positioning Teeth For Conventional Bridges

Although resin-bonded bridges appear esthetic, they are highly technique sensitive. If not constructed prop-

erly, this type of fixed restorations has a short clinical life. Even under ideal conditions, the average life of a resin-bonded anterior bridge replacing a missing maxillary lateral incisor is less than ten years.<sup>9,10</sup> Another option for restoring an edentulous space in the maxillary



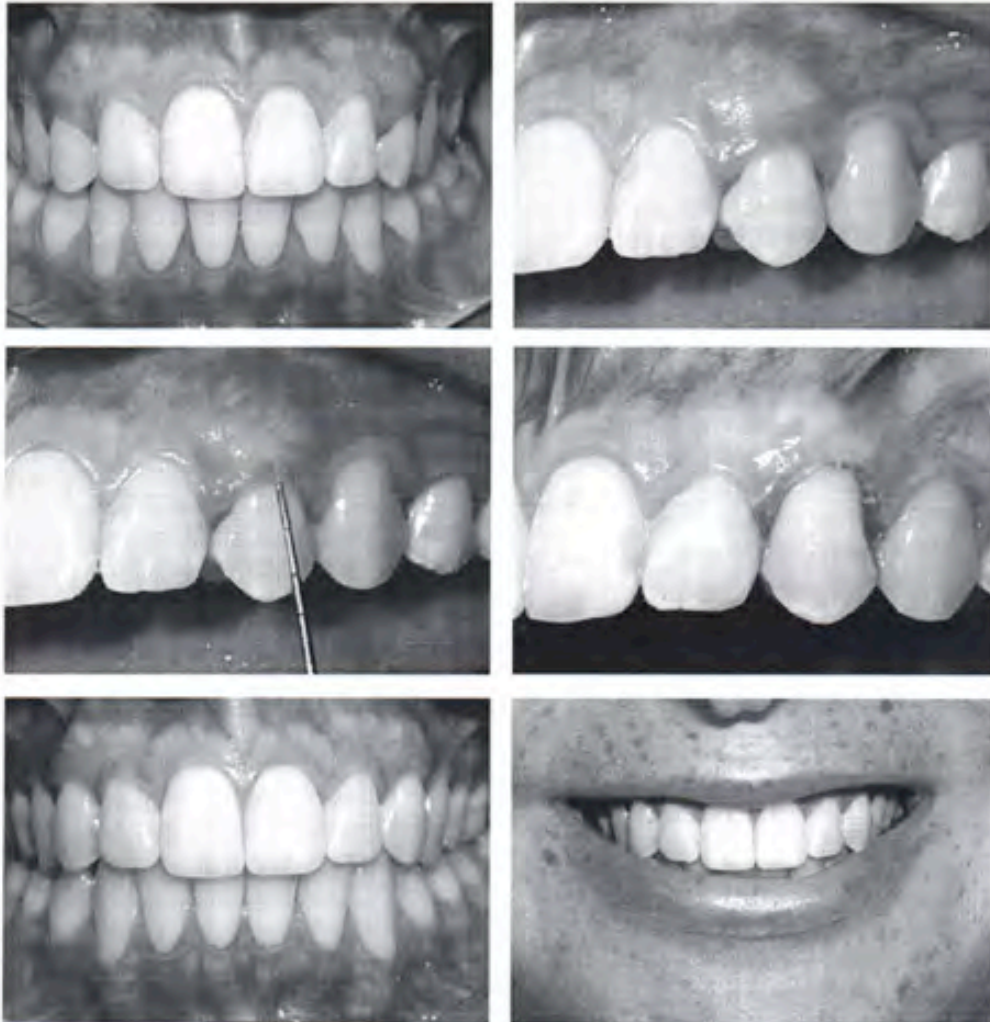


Figure 25-11. Improving gingival levels with canine substitution. If the premolars are placed in the canine position after orthodontic therapy, their esthetic appearance is compromised, because they are shorter than the typical canine crown (*A,B*). However, if the labial sulcular depth of the premolar is greater than one millimeter (*C*), the excess gingiva can be removed surgically (*D*). This relatively simple procedure will add length to the premolar crown, improve the esthetic balance of the anterior gingival margins, and help create the illusion that the premolar is a canine.

anterior region in an adolescent or young adult is a conventional fixed bridge. However, these are generally only used if the adjacent teeth require crowns, have had significant trauma, or have had root canal therapy. If extensive restorations are planned for the adjacent teeth, it is reasonable to consider a conventional bridge in the anterior region in an adolescent patient.

The abutments for a conventional bridge must be positioned appropriately, so the crown preparations of the two abutments will have parallel walls to permit seating of the soldered bridge. If the patient's central incisors or canines are proclined relative to one another (Fig. 25-13), the abutments could require extensive reduction to achieve parallel preparations. This relationship could

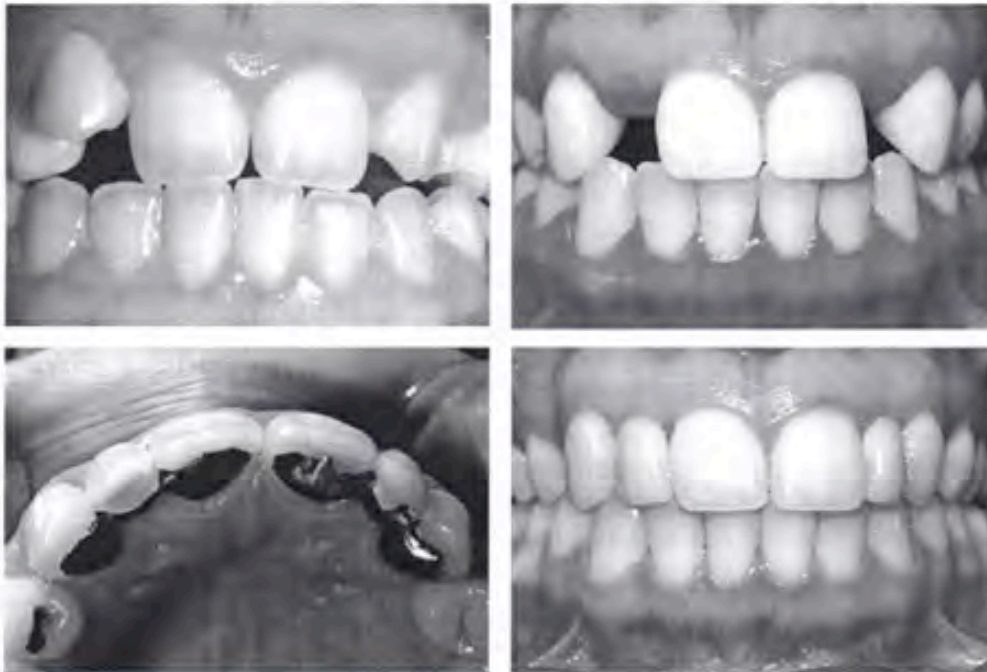


Figure 25-12. Resin-bonded bridges to replace missing maxillary lateral incisors. In this patient, the maxillary lateral incisors were congenitally absent (A). Analysis of profile and occlusion showed that opening space (B) for resin-bonded bridges (C,D) was the best solution. In these situations, the overbite of the central incisors must be minimal, and should only be enough to produce posterior discusion in anterior protrusive occlusion. In addition, the central incisor and canine abutments should be positioned more upright so the forces of occlusion will produce a shear force on the metal connectors resulting in fewer failures of the bridge due to debonding.

reduce the retention of the preparation, and in some instances require root canal therapy of the abutment teeth. As a general rule, the axial inclinations of the abutment crowns should be perpendicular to the occlusal plane. This orientation will result in the least amount of tooth reduction and the greatest amount of retention of the preparations.

#### Timing Of Lateral Incisor Implant Placement

A third option for replacing a missing maxillary lateral incisor is an implant. If this option were chosen, several factors must be considered. First of all, the age of the patient is vitally important. If an implant is placed before a patient has completed facial growth, then the adjacent teeth will continue to erupt as the maxilla and

mandible continue to grow. A recent study<sup>13</sup> has shown that facial growth continues on average until about 17 years of age in females and about 21 years of age in males. There are males and females who complete facial growth before and after these average ages, so the orthodontist must help the surgeon to determine whether or not facial growth has ceased.

The best means for assessing the completion of facial growth is to superimpose sequential lateral cephalometric head radiographs.<sup>7,13</sup> By registering the superimposition on the base of the skull (sella, greater wings of the sphenoid, and cribriform plate), the clinician may determine if the distance between nasion and menton has increased between successive films. The radiographs should be taken least six months to one year apart. If no change has occurred in the nasion menton distance in one year, then facial growth is complete, and the implant may be placed.

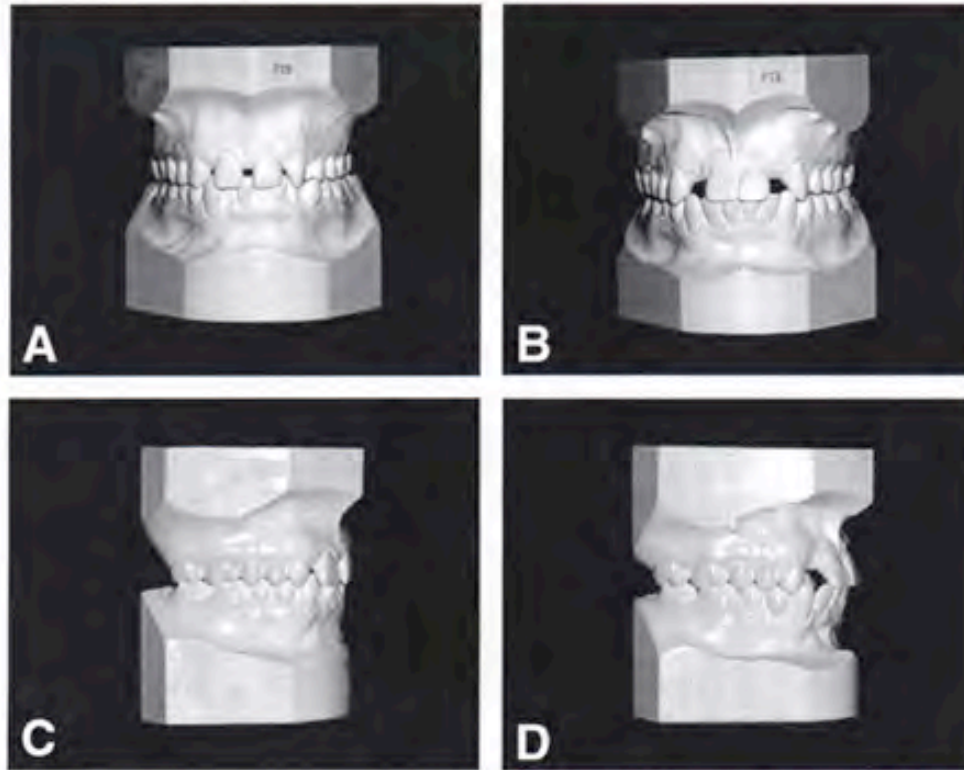


Figure 25-13. Inappropriate angulation of bridge abutments. In this patient, both maxillary lateral incisors were congenitally absent (A). The patient had a Class I occlusion (C), an acceptable facial profile, and minimal mandibular arch length deficiency. Therefore, space was opened for two anterior conventional bridges with pontics for the lateral incisors (B,D). Unfortunately, the teeth were proclined significantly to create pontic space. As a result, the central and canine crowns are not parallel, and therefore crown preparations will not draw without severely over-reducing the teeth. The orthodontist must be aware of abutment crown angulation during preparation for conventional bridges and make certain that the crowns are parallel with one another to facilitate bridge construction.

### Creating Space For A Lateral Incisor Implant

A second factor that the orthodontist must be aware of is the amount of mesiodistal space that is created for the lateral incisor implant.<sup>7</sup> First of all, if a contralateral incisor is present, the space for the missing lateral incisor crown should match the width of the natural lateral incisor. In general this space should be at least 5.5 mm wide. If the contralateral lateral incisor is malformed or peg-shaped and is smaller than 5.5 mm, then the crown should be built-up to a width that is 67–75% the width of the central incisor. The width of most central incisors ranges from 8 to 10 mm wide. Therefore, the width of

the lateral incisor implant crown should range from about 5.5 to 7.0 mm.

The width of the edentulous space should allow at least 1 mm between the implant and the adjacent teeth. If the distance between implant and tooth is less than 1 mm, the interproximal bone could be jeopardized, and the space for the papilla between the implant crown and the adjacent teeth will be constricted and could appear much shorter than the contralateral papillae.<sup>7</sup> This situation will make the implant crown more obvious and appear less esthetic.

The space between the roots of the adjacent central incisor and canine must be sufficient to permit placement of the implant (Fig. 25-14). As space is created



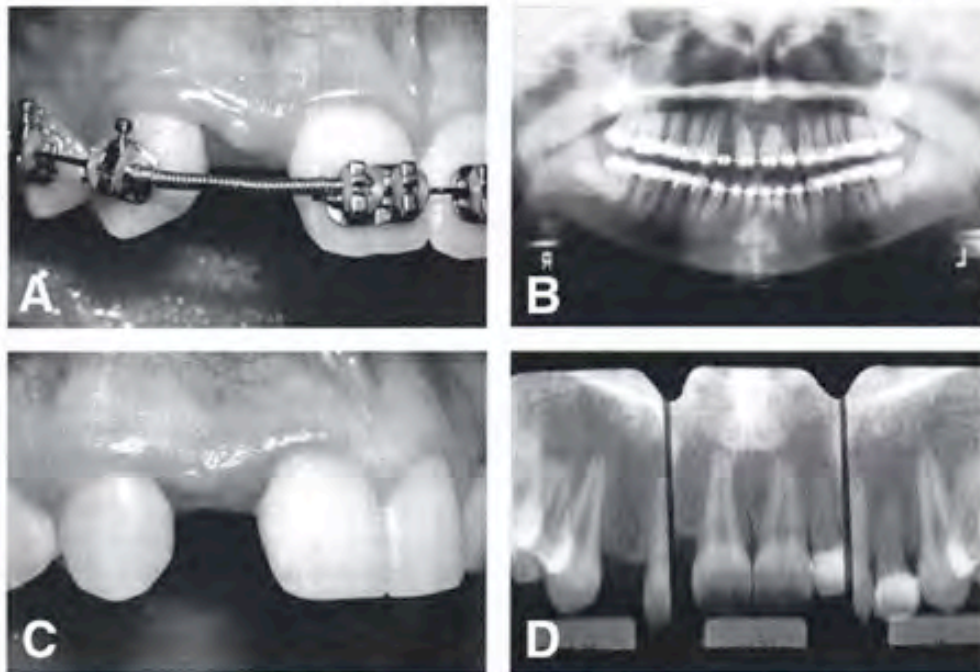


Figure 25-14. Root angulation for anterior implants. This patient is missing the maxillary right lateral incisor, and space is being opened for an implant (A). As the crowns move apart (A), the root apices move closer together (B). During orthodontic finishing, the roots must be moved apart to create sufficient space for the eventual crown (C) and implant (D).

between a central incisor and canine by pushing the crowns apart, the roots tend to move toward one another. This root proximity must be corrected prior to implant placement. This type of tooth movement is accomplished by progressively bending the archwires to move the apices of the roots in opposite directions.

#### Implant Site Development

The labiolingual dimension of the alveolar ridge must be wide enough to place the implant in its proper position. If insufficient ridge width exists, a bone graft may be necessary before or during implant placement (Fig. 25-15). The type of bone may be either autogenous or freeze-dried cadaver bone. Both types of graft material will become remodeled and form an adequate osseous housing for the implant.<sup>14-18</sup>

A bone graft can be avoided if the central incisor and canine erupt adjacent to one another (Fig. 25-16). As the space is opened orthodontically for the future implant, bone is laid down along fiber tracks of the peri-

odontal membrane.<sup>7</sup> The labiolingual width of the alveolar ridge formed in this manner generally is stable over time. Therefore, if implant placement is delayed until an adolescent has completed facial growth, the ridge will not become narrower.

#### Retaining The Implant Space

The edentulous space for the implant should be maintained during and after orthodontic therapy. A plastic tooth with a bracket may be placed in the edentulous space during orthodontic therapy to maintain the space for the future implant (Fig. 25-17). The plastic tooth should be contoured so it does not impinge on the gingiva near the adjacent teeth.<sup>7</sup> It must be contoured to maintain the health of the future papilla between the implant and the adjacent dentition.

After orthodontic treatment, a retainer with a prosthetic tooth in the implant site should be used to maintain the implant space (Fig. 25-17). The tooth should be secured to the retainer with a wire embedded into the

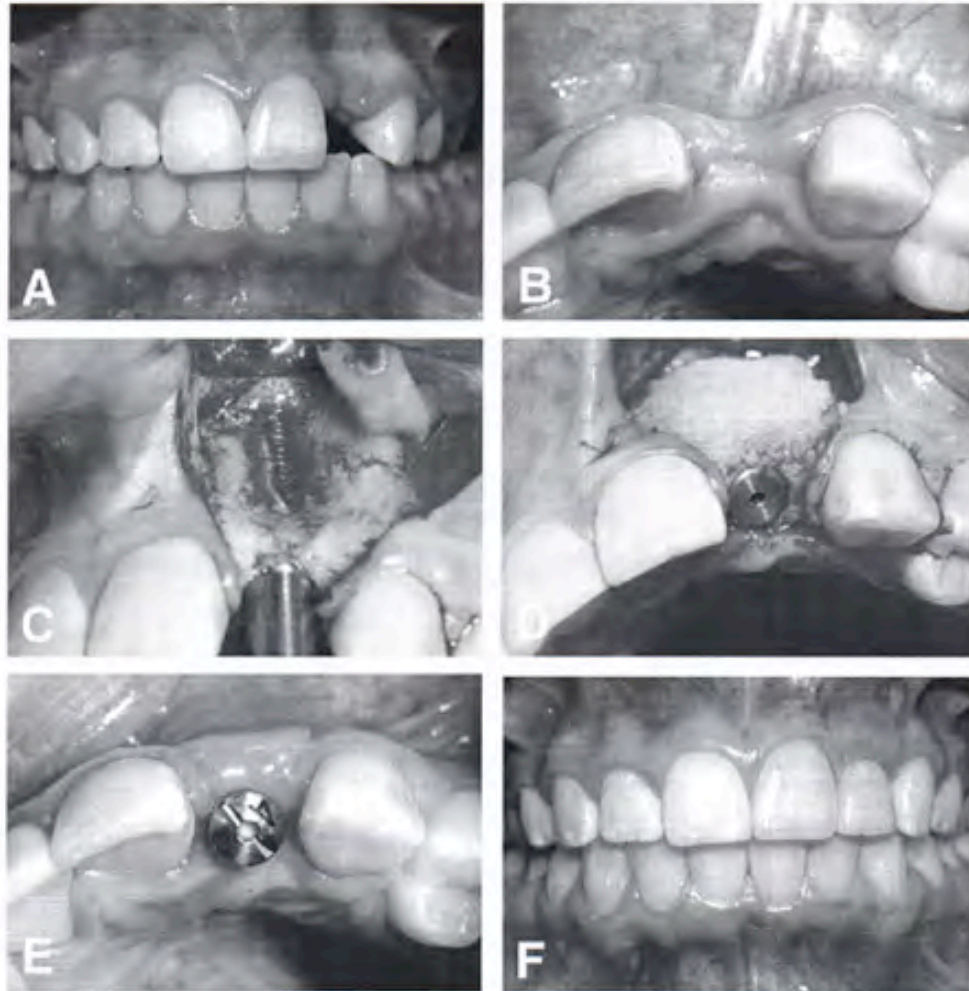


Figure 25-15. Bone grafting to create an implant site. Orthodontic treatment had been completed on this patient, and her maxillary left lateral incisor was avulsed in a sports accident (A). Her alveolar ridge narrowed significantly (B), before the implant could be placed. A significant fenestration was produced (C) during the implant placement, so a freeze-dried, decalcified bone graft was placed to re-enforce the implant (D). The bone graft created a wider labiolingual dimension to the ridge (E), and produced a more esthetic final restoration (F).

acrylic and the tooth.<sup>7</sup> This wire will reinforce the retainer and prevent accidental fracture of the tooth from the retainer if the acrylic in this area is reduced when the implant is uncovered. If the implant placement will be delayed for several years, while the clinician is waiting for growth to be completed, a temporary resin-bonded bridge may be used instead of a removable retainer.

#### Need For Gingivectomy Before Implant Placement

Another aspect of implant placement that is more important in adolescents than in adults is the level of the gingival margin at the conclusion of the orthodontic therapy (Fig. 25-18). In most implant systems, the head

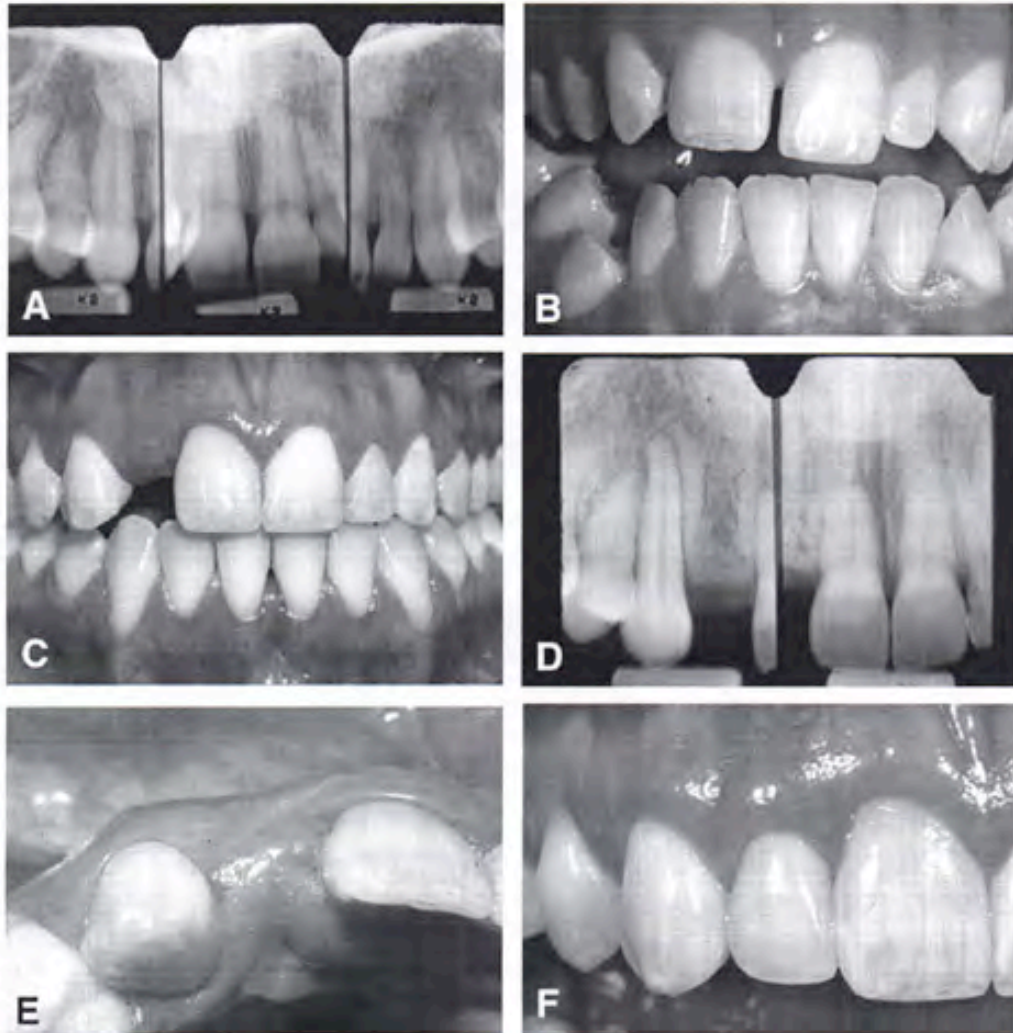


Figure 25-16. Orthodontic implant site development. This patient has an ideal situation for developing an implant site to replace her congenitally absent maxillary right lateral incisor (A). The central and canine have erupted adjacent to one another (B). As space was opened for the implant (C), bone was laid down between the roots, as they were moved apart (D,E). This produces an excellent ridge for the surgeon to place the implant, eliminates the need for a bone graft, thereby reduces the surgical trauma to the implant site, and results in better papillae adjacent to the implant crown.

of the implant must be placed 4 millimeters from the future gingival margin of the implant crown. In some late-adolescent patients, however, the level of the labial gingival margin may not have achieved its adult position. In most adolescents, the alveolar bone may be positioned at the level of the cemento-enamel junction of the

adjacent teeth. In contrast, the crest of the bone generally is about 2 millimeters apical to the CEJ in most adults. Therefore, it is critical to know the exact position of the labial gingival margin prior to implant placement. Because the head of the implant must be 4 mm from the eventual gingival margin, some adolescent patients re-



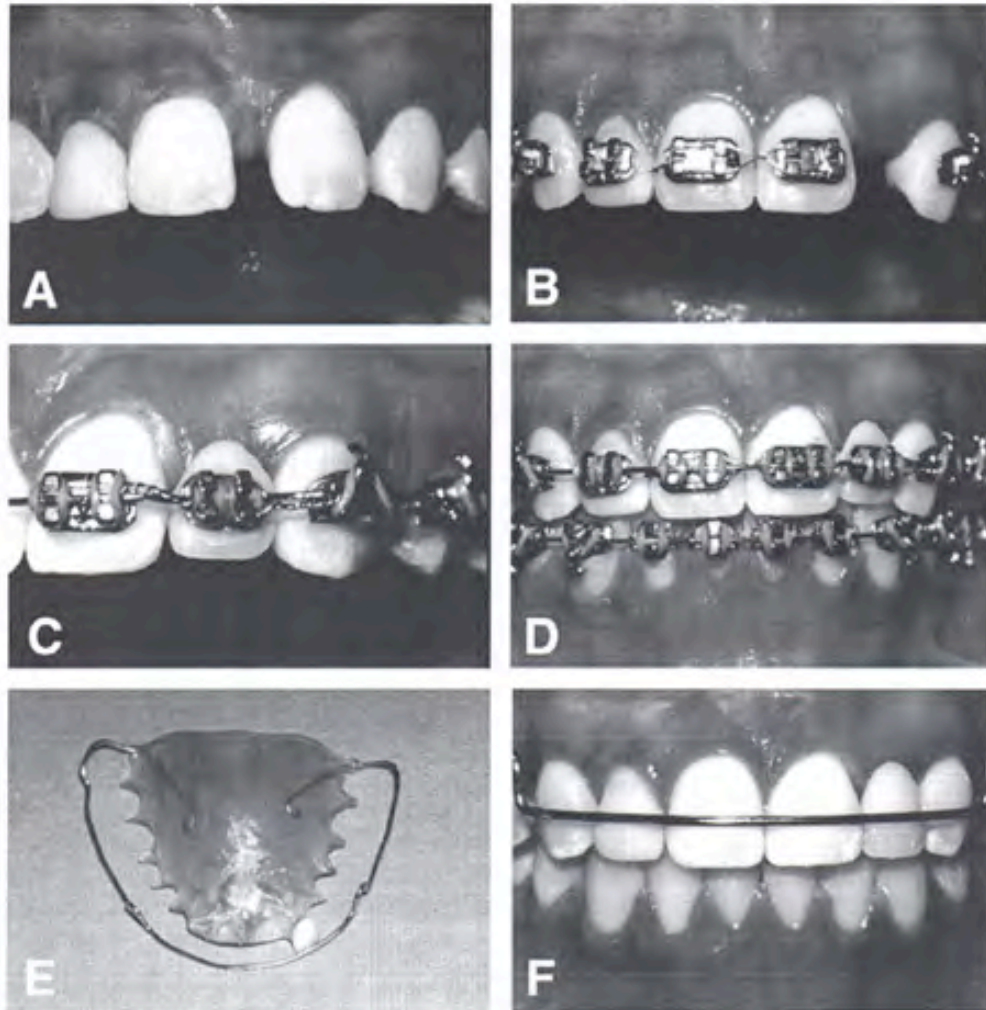


Figure 25-17. Retaining the implant site during and after orthodontics. This patient is congenitally missing her maxillary left lateral incisor (A). Space was opened for an implant (B). In order to maintain the space during orthodontic finishing, and provide an esthetic replacement for the patient, a plastic pontic was constructed and placed in the edentulous site (C). The gingival embrasures on the pontic were opened to avoid damaging the ridge in the future implant site. In addition, the occlusion was adjusted (D) so the pontic tooth did not occlude with the opposing arch. After orthodontics, an acrylic circumferential retainer with a prosthetic tooth (E) is used to hold the space for an eventual implant. The plastic retainer tooth was also shaped at the gingiva to avoid impinging on the tissue in the implant site (F).

quire gingival surgery (Fig. 25-18), with or without bone removal before implant placement, so that the implant can be positioned in its proper vertical relationship relative to its expected gingival margin.<sup>7</sup>

Implants have become an important part of restorative dentistry for patients who are congenitally missing teeth as well as for those patients where teeth were extracted due to extensive caries, trauma, or periodon-

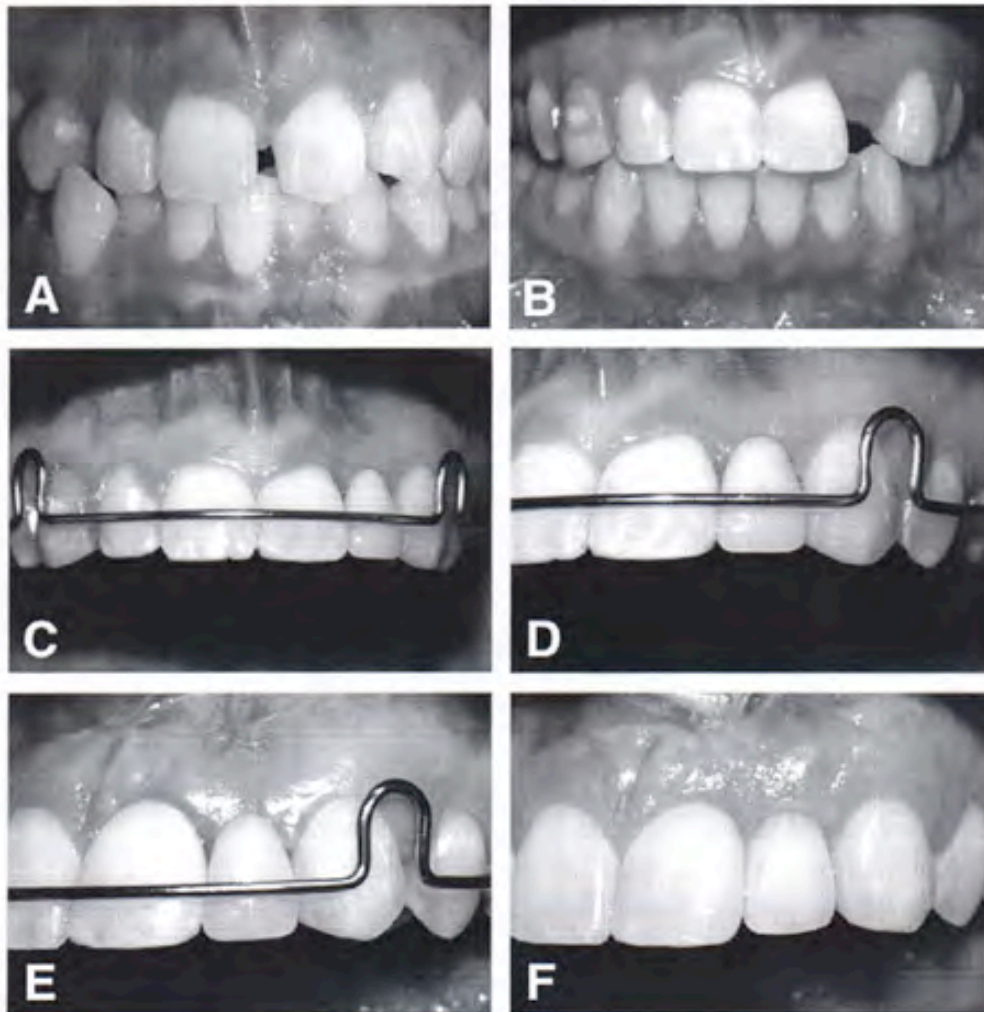


Figure 25-18. Gingival surgery prior to implant placement. This patient was congenitally missing her maxillary left lateral incisor (A), and space was opened for an implant (B). However, although the length of the plastic pontic matches the crown length of the contralateral lateral incisor (C), the central incisor appears shorter than the pontic tooth (D). Since the head of the implant must be placed 4 mm from the ultimate gingival margin of the lateral incisor, and since the adjacent central should appear longer than the lateral, gingival surgery was required prior to implant placement to lengthen the central incisor crown (E). By sequencing the gingival surgery prior to implant placement, the final restoration on the implant (F) has the correct gingival margin relationship with the adjacent central incisor and canine.

tal disease. If all members of the team participate correctly, the results can be outstanding. On the other hand, if the team of surgeon, orthodontists, and restorative dentists do not coordinate their efforts properly, the results could be disastrous.

### TRAUMATIC FRACTURE OF TEETH

Occasionally, children and adolescents will fall and accidentally injure their anterior teeth. If the injuries are minor and result in small fractures of enamel, these ir-

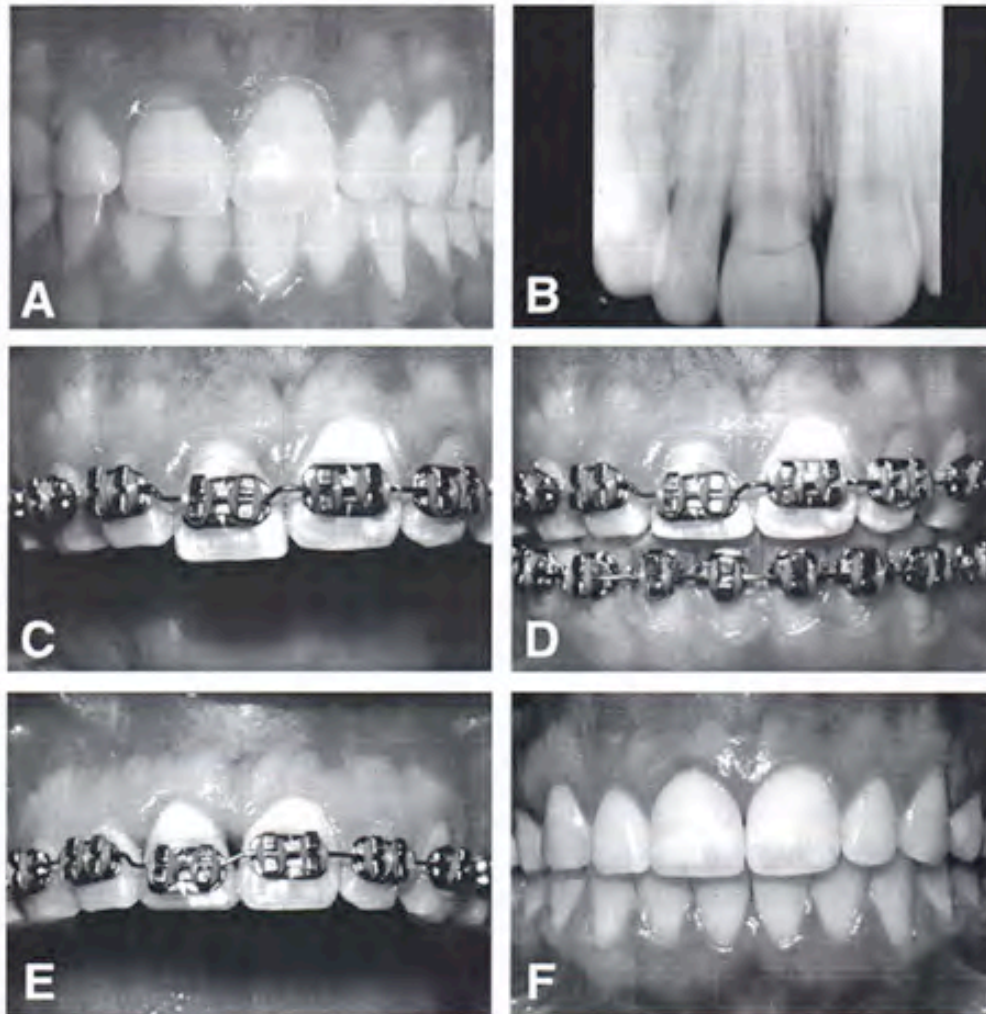


Figure 25-19. Forced eruption of a fractured tooth. This young patient had a severe fracture of the maxillary right central incisor (A) that extended apically to the level of the alveolar crest on the lingual (B). In order to restore the tooth adequately and avoid impinging on the periodontium, the fractured root was extruded four millimeters (C). As the tooth erupted, the gingival margin followed the tooth (D). Gingival surgery was required to lengthen the crown of the central incisor (E), so the final restoration had sufficient ferrule for resistance and retention, and the appropriate gingival margin relationship with the adjacent central incisor (F).

regularities can be restored with light-cured composite or porcelain veneers and in some instance camouflaged through enamel reshaping. In some situations, however, the fracture may extend beneath the level of the gingival margin and terminate at the level of the alveolar ridge (Fig. 25-19). In these situations, restoration of the fractured crown is impossible, because the tooth prepa-

ration would extend to the level of the bone. This over-extension could result in an invasion of the biologic width of the tooth and cause persistent inflammation of the marginal gingiva. In these situations, it may be beneficial to erupt the fractured root out of the bone and move the fracture margin coronally, so that it can be restored without creating gingival inflammation.<sup>19</sup> In



some situations, if the fracture is too severe, it may be better to extract the tooth and replace it with an implant or bridge. The orthodontist and restorative dentist should evaluate six criteria to determine if the tooth should be forcibly erupted or extracted.<sup>18</sup>

### Criteria For Selecting Forced Eruption

**Root Length.** The first criterion is root length. Is the root long enough, so that a one-to-one crown-root ratio will be preserved after the root has been erupted? In order to determine the answer to this question, the clinician must know how far to erupt the root. If a tooth fracture extends to the level of the bone, it must be erupted four millimeters. The first two and one-half millimeters will move the fracture margin far enough away from the bone to prevent a biologic width problem. The other one and one-half millimeters will provide the proper amount of ferrule for adequate resistance form of the crown preparation. Therefore, if the root is fractured to the bone level and must be erupted four millimeters, the clinician must evaluate a periapical radiograph (Fig. 25-19) and subtract four millimeters from the end of the fractured tooth root. Then the length of the residual root should be compared with the length of the eventual crown on this tooth. The root to crown ratio should be about one to one. If the root to crown ratio is less than this amount, too little root may remain in the bone for stability. In the latter situation, it may be more prudent to extract the root and place a bridge or implant.

**Root Form.** Root form is the second criterion that determines whether forced eruption is feasible. The shape of the root should be broad and non-tapering rather than thin and tapered. A thin, tapered root will provide a narrower cervical region after the tooth has been erupted four millimeters; this could compromise the esthetic appearance of the final restoration. The internal root form also is important. If the root canal is wide, the distance between the external root surface and root canal filling will be narrow. In these situations, the walls of the crown preparation will be thin, which could result in early fracture of the restored root. The root canal should not be more than a third of the overall width of the root. In this way, the root still could provide adequate strength for the final restoration.

**Level of Fracture.** A third criterion that determines whether a fractured root should be erupted is the level of the fracture. If the entire crown is fractured 2 to 3 millimeters apical to the level of the alveolar bone, it is difficult if not impossible to attach to the root in order to erupt it.

**Relative Importance.** The fourth criterion is the relative importance of the tooth. If the patient were 70 years of age, and both adjacent teeth had prosthetic crowns, then it could be more prudent to simply construct a bridge attaching to the crowned teeth. However, if the patient were 15 years of age and the adjacent teeth were unrestored, then forced eruption would be much more conservative and appropriate.

**Esthetics.** The fifth criterion to evaluate prior to beginning forced eruption of a fractured root is esthetics. If the patient has a high lip line and shows 2 to 3 mm of gingival when smiling, then any type of restoration in this area will be more obvious. In this situation, keeping the patient's own tooth would be much more esthetic than any type of implant or prosthetic replacement.

**Prognosis.** The sixth and final criterion to determine whether or not a tooth should be erupted is the endo/periodo prognosis. If the tooth has a significant periodontal defect, it may not be possible to salvage the root. In addition, if the tooth root has a vertical fracture, then it is hopeless and must be extracted.

### Mechanics For Forced Eruption

If all of these factors are favorable, then forced eruption of the fractured root is indicated. The orthodontic mechanics necessary to erupt the tooth can vary from elastic traction to orthodontic banding and bracketing.<sup>19</sup> If a large portion of the tooth still is present, then orthodontic bracketing will be necessary (Fig. 25-19). If the entire crown has fractured leaving only the root, then elastic traction from a bonded bar may be possible.

The tooth root may be erupted rapidly or slowly. If the movement is performed rapidly, the alveolar bone will be left behind temporarily, and a circumferential fibrotomy may be performed to prevent bone from following the erupted root. If the root is erupted slowly, however, the bone will follow the tooth. In this situation, the erupted root will require crown lengthening (Fig. 25-19), and an apically positioned flap to expose the correct amount of tooth to create the proper ferrule, resistance form, and retention for the final restoration.

### Stabilization After Extrusion

After the tooth root has been erupted, it must be stabilized to prevent it from intruding back into the alveolus. The reason for re-intrusion is the orientation of the principal fibers of the periodontium. During forced eruption, the periodontal fibers become oriented

obliquely and stretched as the tooth root moves coronally. These fibers eventually will reorient themselves after about six months. Before this time, the tooth root can re-intrude significantly. Therefore, if this type of treatment is performed, an adequate period of stabilization is necessary to avoid significant relapse and re-intrusion of the root.

### Need For Gingival Surgery

As the root erupts, the gingiva will move coronally with the tooth. As a result, the clinical crown length will become shorter after extrusion. In addition, the gingival margin may be positioned more incisally than adjacent teeth. In these situations, gingival surgery is necessary to create ideal gingival margin heights. The type of surgery varies depending upon whether or not bone removal will be necessary. If bone has followed the root during eruption, the surgeon will elevate a flap and remove the appropriate amount of bone to match the bone height of the adjacent teeth. If the bone level is flat between adjacent teeth, a simple excisional gingivectomy will correct the gingival margin discrepancy.

After gingival surgery, an open gingival embrasure may exist between the erupted root and adjacent teeth (Fig. 25-19). This space occurs because the narrower root portion of the erupted tooth has been moved into the oral cavity. This space may be closed in two different ways. One method involves overcontouring of the replacement restoration. The other method involves reshaping of the crown of the tooth, and movement of the root to close the space. This latter method often helps to improve the overall shape of the final crown on the restored tooth.

## UNEVEN GINGIVAL MARGINS

### Background

Ideally, the gingival margins of the maxillary central incisors should be at the same level. The gingival margins of the lateral incisors should be positioned slightly coronal to the centrals, and the gingival margins over the canines should be at the same level as the central incisors.<sup>20</sup> However, in some adolescents, the gingival margins are uneven (Figs. 25-20 and 25-21). If the patient has a high lip line during smiling, this discrepancy in gingival margin heights can produce an unesthetic smile in spite of well-aligned teeth. In order to correct this discrepancy, the clinician must determine if the gingival margin discrepancy is due to abnormal wear and

compensatory eruption of the teeth, or abnormal gingival margin location requiring gingival surgery.

### Orthodontic Intrusion Of Short/Abraded Teeth

In order to diagnose this problem adequately, the clinician must first evaluate the labial sulcular depth of the maxillary incisors. If the sulcular depths are uniformly 1 mm, then the discrepancy in gingival margins may be due to uneven wear or trauma of the incisal edges of the anterior teeth (Fig. 25-20). Although most adolescents do not have significant attrition of their incisal edges, it does occur occasionally. In these situations, the clinician must decide if the amount of gingival discrepancy will be noticeable. If so, bracketing and alignment of these teeth must be accomplished in a way that improves the esthetics and restorability of the abraded teeth.<sup>21-24</sup> In these instances, the gingival margins are used as a guide in tooth positioning, not the incisal edges. As the gingival margins are aligned, the discrepancy in the incisal edges becomes more apparent. These incisal discrepancies are restored with composite restorations temporarily and then are restored permanently with porcelain veneer restorations when the adolescent patient reaches adulthood.

If the gingival margin discrepancies are corrected by leveling the gingival margins orthodontically, these tooth positions should be maintained for at least six months to avoid relapse. As teeth are intruded, the orientation of the periodontal fibers changes and becomes more oblique. It typically takes at least six months for these fibers to re-orient themselves in the horizontal position and stabilize the tooth position.

### Surgery To Level Gingival Margins

If the discrepancy in gingival margin position is due to differences in the sulcular depths over the maxillary incisors, then the correct method for dealing with these discrepancies is with gingival surgery (Fig. 25-21). If the level of the alveolar bone is positioned 1-2 mm apical to the cemento-enamel junction, and the patient has sufficient attached gingiva, then the surgical procedure should be a simple excisional gingivectomy. If the bone level is located at the CEJ, however, or if the patient has insufficient attached gingiva, then an apically positioned flap is the correct procedure. In either situation, the change in the position of the gingival margins can be a tremendous improvement in the esthetic appearance of the patient's smile.<sup>25-30</sup>

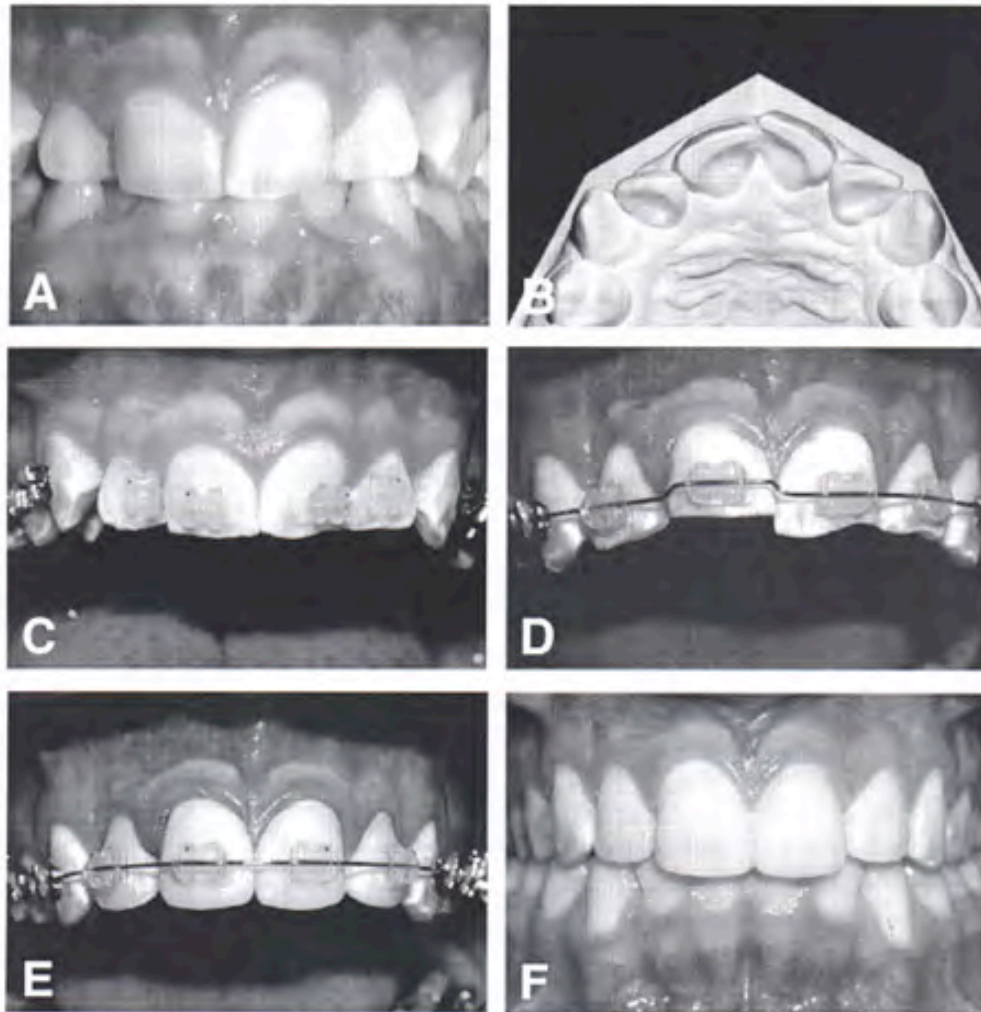


Figure 25-20. Orthodontic intrusion and restoration of abraded teeth. This adolescent patient had a protrusive bruxing habit that resulted in extensive wear of the maxillary central and lateral incisors (*A,B*). In order to provide the restorative dentist with sufficient space to add length to the central incisors, the brackets were positioned initially near the incisal edges of the centrals and laterals (*C*). As the teeth aligned, the incisors were intruded (*D*), using the gingival margins of the canines and central incisors as a guide. When the gingival margins were positioned correctly, the incisal edges were restored (*E*), and the brackets were replaced to complete the orthodontics. The final result shows crown lengths (*F*) that are proportional with the widths of the anterior teeth.

### OPEN GINGIVAL EMBRASURES

Occasionally at the end of orthodontic therapy, an adolescent patient may have an open gingival embrasure between the maxillary central incisors. This space is

usually due to one of three causes: tooth shape, root angulation, or periodontal bone loss. As most adolescent patients do not have significant periodontal problems, open gingival embrasures in teenagers are due to tooth shape or root angulation.



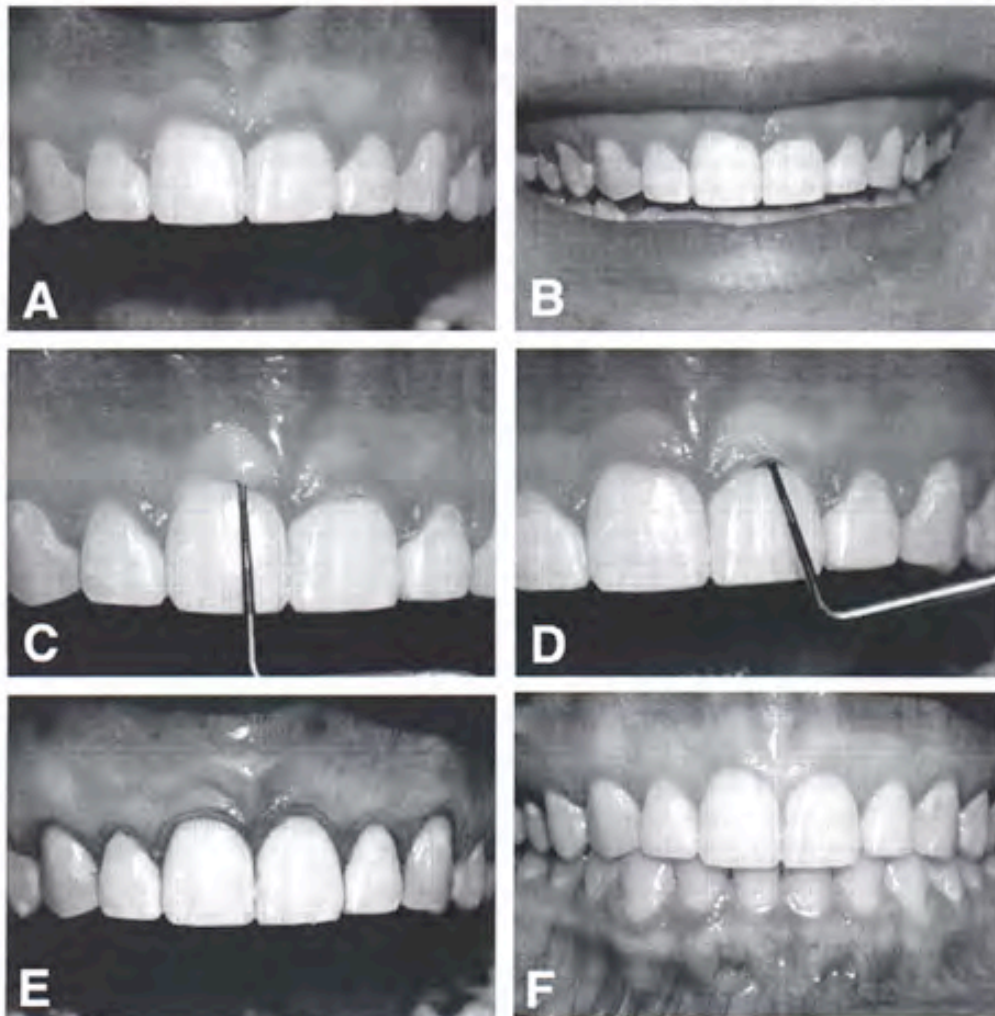


Figure 25-21. Gingival surgery to establish appropriate crown length. This patient had uneven crown lengths of the central incisors (A), and this unesthetic relationship was apparent when she smiled (B). In order to determine the correct solution for this discrepancy, the sulci of the two central incisors were measured (C,D) with a periodontal probe. Since the sulcus of the left central was deeper than the right, gingival surgery (E) could be used to establish the correct gingival levels between the centrals, laterals and canines (F).

The interproximal contact between the maxillary central incisors consists of two parts. One portion is the tooth contact and the other portion is the papilla. The ratio of papilla to contact is one to one. In other words, half the space is occupied by papilla and half is formed by the tooth contact. If the patient has an open embrasure, the

first aspect that the clinician should evaluate is whether the problem is due to the papilla or the tooth contact. If the papilla is the problem, then the cause is usually a lack of bone support due to an underlying periodontal problem. However, most adolescents do not have periodontal bone loss between the maxillary central incisors.

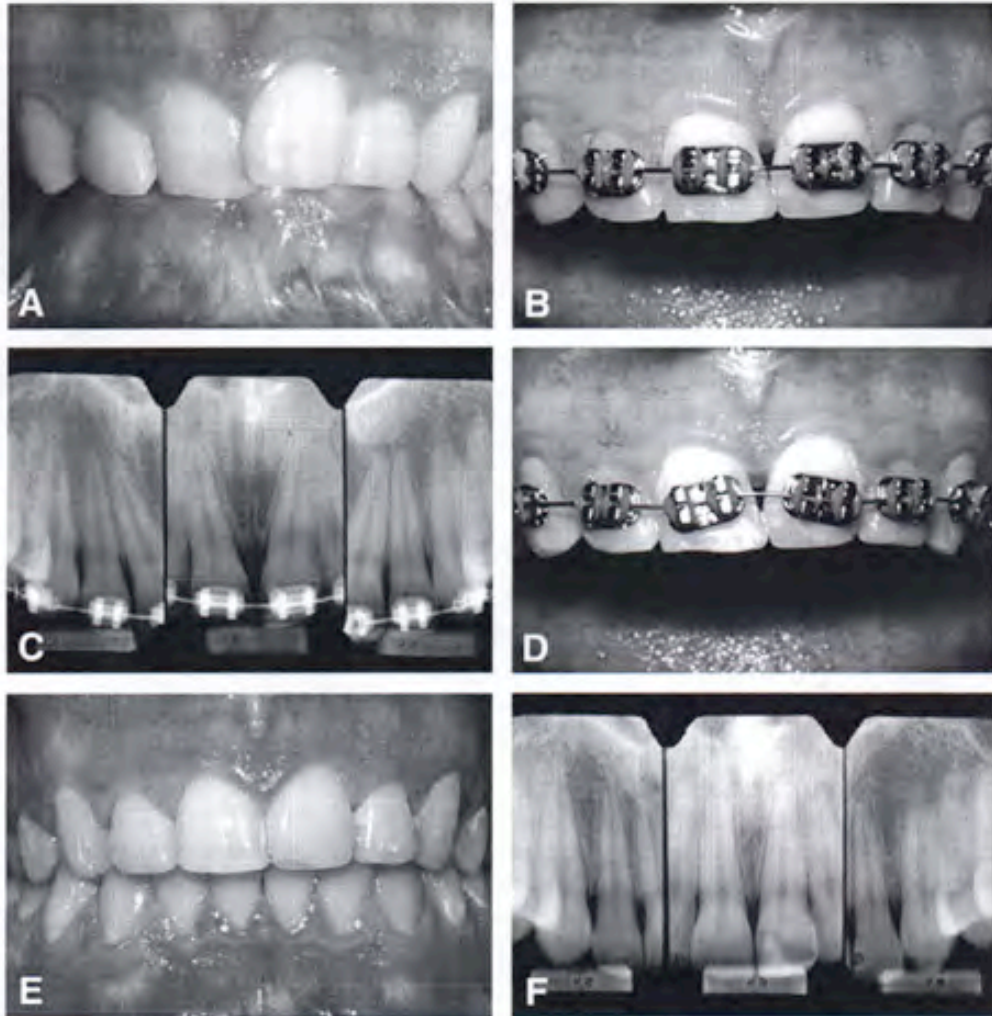


Figure 25-22. Correction of open gingival embrasures. This adolescent patient initially had overlapped maxillary central incisors (A), and after initial orthodontic alignment of the teeth, an open gingival embrasure appeared between the centrals (B). A radiograph showed that the open embrasure was caused by divergence of the central incisor roots (C). In order to correct this problem, the central incisor brackets were repositioned (D), and the roots were moved together. This required restoration of the incisal edges after orthodontics (E), since these teeth had worn unevenly prior to orthodontic therapy. As the roots were parallelized (F), the tooth contact moved gingivally, and the papilla moved incisally, resulting in the elimination of the open gingival embrasure.

### Correcting Root Angulation

Therefore, most open embrasures between the central incisors are due to problems with tooth contact.<sup>6</sup> The first step is to evaluate a periapical radiograph of the

central incisors. If the root angulation is divergent (Fig. 25-22), then the brackets should be repositioned so the root position can be corrected. In these situations, the incisal edges may be uneven and require restoration with either composite or porcelain restorations. If the

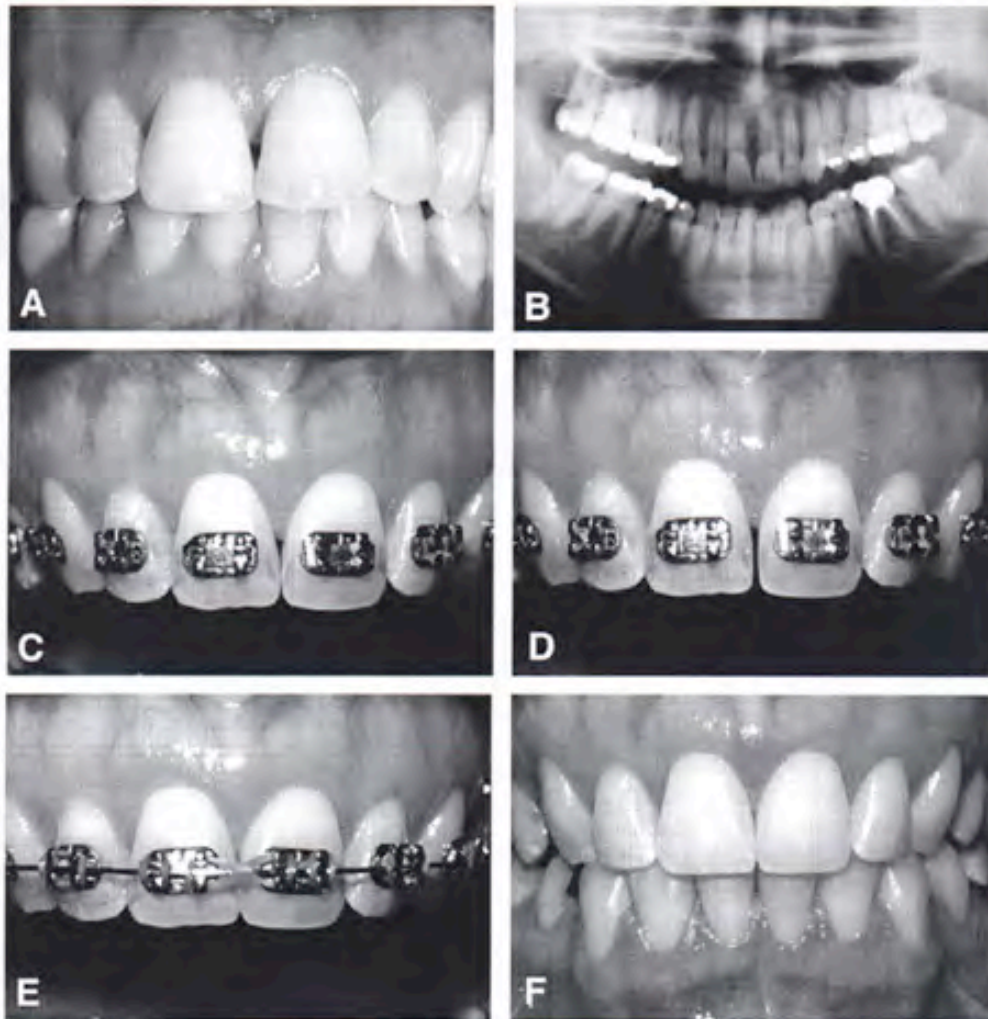


Figure 25-23. Correction of open gingival embrasures. This patient initially had triangular-shaped central incisors (*A,B*), which produced an open gingival embrasure after orthodontic alignment (*C*). Since the roots of the central incisors were parallel with one another, the appropriate solution for the open gingival embrasure was to recontour the mesial surfaces of the central incisors (*D*). As the diastema was closed (*E*), the tooth contact moved gingivally, and the papilla moved incisally, resulting in the elimination of the open gingival embrasure (*F*).

periapical radiograph shows that the roots are in their correct relationship, then the open gingival embrasure is due to triangular tooth shape.

#### Reshaping/Restoring Teeth

If the shape of the tooth is the problem, two solutions are possible. One possibility is to restore the open gin-

gival embrasure. The other option is to reshape the tooth (Fig. 25-23) by flattening the incisal contact and closing the space.<sup>5</sup> This reshaping will result in lengthening of the contact until it meets the papilla. In addition, if the embrasure space is large, closing the space will squeeze the papilla between the central incisors. This compression will help to create a one to one rela-



tionship between the contact and papilla and restore uniformity to the heights between the midline and adjacent papillae.

## FINAL REMARKS

This chapter has focused on the interrelationship between the orthodontist, periodontist, and restorative dentist in the management of adolescent patients with restorative problems. It is important for the orthodontist to think like a restorative dentist during the planning of treatment for adolescent patients. It is no longer adequate to simply align the incisal edges of teeth and expect to obtain an ideal result. Many adolescent patients can benefit from a coordinated approach of orthodontic tooth positioning and adjunctive restorative dentistry to overcome common restorative and esthetic dilemmas. It also is important for the orthodontist to educate their restorative colleagues about those types of restorative problems that could benefit from pre-restorative tooth positioning prior to final restoration. Teamwork is truly an important concept.

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