Special Considerations in Treatment for Adults

Adjunctive Versus Comprehensive Treatment

Adjunctive orthodontic treatment for adults is, by definition, tooth movement carried out to facilitate other dental procedures necessary to control disease, restore function and/or enhance appearance. Almost always, it involves only a part of the dentition, and the primary goal usually is to make it easier or more effective to replace missing or damaged teeth. Making it easier for the patient to control periodontal problems is a frequent secondary goal, and sometimes is the primary goal. The treatment duration tends to be a few months, rarely more than a year, and long-term retention usually is supplied by the restorations. With the distinction made in this way, most of the adjunctive treatment discussed in this chapter can be carried out within the context of general dental practice. Whether one or several practitioners are involved, adjunctive orthodontics must be coordinated carefully with the periodontal and restorative treatment.

In contrast, the goal of comprehensive orthodontics for adults is the same as for adolescents: to produce the best combination of dental occlusion, dental and facial appearance, and stability of the result to maximize benefit to the patient. Typically, comprehensive orthodontics requires a complete fixed orthodontic appliance, intrusion of some teeth is likely to required, orthognathic surgery may be considered to improve jaw relationships, and the duration of treatment from braces on to braces off exceeds 1 year. Adults receiving comprehensive treatment are the main candidates for esthetically-enhanced appliances, the prime examples being clear aligners, lingual appliances, and ceramic facial brackets. The complexity of the treatment procedures means that an orthodontic specialist is likely to be significantly more efficient in delivering the care.

The first part of this chapter is devoted to adjunctive treatment, carried out in large part with fixed appliances that involve only selected areas of the dental arches. The second part covers non-surgical comprehensive adult treatment. The integration of orthodontics and orthognathic surgery is discussed in Chapter 19.

Goals of Adjunctive Treatment

Typically, adjunctive orthodontic treatment will involve any or all of several procedures: (1) repositioning teeth that have drifted after extractions or bone loss so that more ideal fixed or removable partial dentures can be fabricated, or so that implants can be placed; (2) alignment of anterior teeth to allow more esthetic restorations or successful splinting, while maintaining good interproximal bone contour and embrasure form; (3) correction of crossbite if this compromises jaw function (not all do); and (4) forced eruption of badly broken down teeth to expose sound root structure on which to place crowns.

Whatever the occlusal status originally, the goals of adjunctive treatment should be to:

- Improve periodontal health by eliminating plaque-harboring areas and improving the alveolar ridge contour adjacent to the teeth
- Establish favorable crown-to-root ratios and position the teeth so that occlusal forces are transmitted along the long axes of the teeth
- Facilitate restorative treatment by positioning the teeth so that
- More ideal and conservative techniques (including implants) can be used
- Optimal esthetics can be obtained with bonding, laminates or full coverage porcelain restorations

An old rule says that to make it clear what something is, it helps to point out what it isn't but might be mistaken for. So, some important corollaries:

- Orthodontic treatment for temporomandibular dysfunction should not be considered adjunctive treatment
- Although intrusion of teeth can be an important part of comprehensive treatment for adults, it should be avoided as an adjunctive procedure because of the technical difficulties involved and the possibility of periodontal complications. As a general guideline for adjunctive treatment, lower incisor teeth that are excessively extruded are best treated by reduction of crown height, which has the added advantage of improving the ultimate crown-to-root ratio of the teeth. For other teeth, tooth-lip relationships must be kept in mind when crown height reduction is considered.
- Crowding of more than 3-4 mm should not be attempted by stripping enamel from the contact surfaces of the teeth. It may be advantageous to strip posterior teeth to provide space for alignment of the incisors, but this requires a complete orthodontic appliance and cannot be considered adjunctive treatment.

Principles of Adjunctive Treatment

Diagnostic and Treatment Planning Considerations

Planning for adjunctive treatment requires two steps: (1) collecting an adequate diagnostic data base and (2) developing a comprehensive but clearly stated list of the patient's problems, taking care not to focus unduly on any one aspect of a complex situation. The importance of this planning stage in adjunctive orthodontic treatment cannot be overemphasized, since the solution to the patient's specific problems may involve the synthesis of many branches of
dentistry. In adjunctive treatment, the restorative dentist usually is the principal architect of the treatment plan, and the orthodontics (whether or not an orthodontist is part of the treatment team) is to allow better restorative treatment. Nevertheless, the steps outlined in Chapter 6 should be followed when developing the problem list. The interview and clinical examination are the same, whatever the type of orthodontic treatment. Diagnostic records for adjunctive orthodontic patients, however, differ in several important ways from those for adolescents and children.

For this adult and dentally compromised population, the records usually should include individual intraoral radiographs to supplement the panoramic film that often suffices for younger and healthier patients (Figure 18-1). When active dental disease is present, the panoramic radiograph does not give sufficient detail. The revised guidelines promulgated by the U.S. Food and Drug Administration in late 2004 (see Chapter 6) should be followed in determining exactly what radiographs are required in evaluating the patient's oral health status.

For adjunctive orthodontics, pretreatment cephalometric radiographs usually are not required, but it is important to anticipate the impact of various tooth movements on facial esthetics. In some instances, the computer prediction methods used in comprehensive treatment (see Chapter 7) can be quite useful in planning adjunctive treatment. Articulator-mounted casts are likely to be needed, because they facilitate the planning of associated restorative procedures.

Once all the problems have been identified and categorized, the key treatment planning question is: Can the occlusion be restored within the existing tooth positions, or must some teeth be moved to achieve a satisfactory, stable, healthy and esthetic result? The goal of adjunctive treatment, to provide a physiologic occlusion and facilitate other dental treatment, has little to do with Angle's concept of an ideal occlusion.

Figure 18-1 For the periodontically compromised adults who are the usual candidates for adjunctive orthodontics, periapical radiographs of the areas that will be treated, as well as a panoramic radiograph, usually are needed. Periodontal disease now is the major indication for periapical radiographs. For this patient who is a candidate for adjunctive orthodontic treatment, adequate detail of root morphology, dental disease, and periodontal breakdown is obtained only from carefully taken periapical radiographs.

Obviously, the time needed for any orthodontic treatment depends on the severity of the problem and the amount of tooth movement desired, but with efficient use of orthodontic appliances, it should be possible to reach the objectives of adjunctive treatment within 6 months. As a practical matter, this means that like comprehensive orthodontics, most
adjunctive orthodontics cannot be managed well with traditional removable appliances. It requires either fixed appliances or a sequence of clear aligners to get the job done in a reasonable period of time. In addition, it is becoming increasingly apparent that skeletal anchorage makes adjunctive tooth movement more effective and efficient. For adjunctive treatment, this is almost always in the form of bone screws.

**Biomechanical Considerations**

**Characteristics of the Orthodontic Appliance**

For adjunctive treatment, with the possible exception of alignment of anterior teeth, we recommend the 22-slot edgewise appliance with twin brackets (one-half the width of the crown). The rectangular (edgewise) bracket slot permits control of buccolingual axial inclinations, the relatively wide bracket helps control undesirable rotations and tipping, and the larger slot size allows the use of stabilizing wires that are somewhat stiffer than ordinarily might be used in comprehensive treatment.

Recently, the development of clear aligner therapy (CAT—see Chapter 11) has provided an effective type of removable appliance that can be well-suited to alignment of anterior teeth. Removable appliances of the traditional plastic-and-wire type are rarely satisfactory for adjunctive (or comprehensive) treatment. They often are uncomfortable, and are likely to be worn for too few hours per day to be effective. With CAT, both discomfort and interference with speech and mastication are minimized, and patient cooperation improves. A fixed appliance on posterior teeth only is all but invisible, but it is quite apparent on anterior teeth, and the better appearance of a clear aligner also is a factor in choosing it to align anterior teeth. Despite this esthetic advantage, there are biomechanical limitations. Clear aligners make control of root position extremely difficult, and it also is difficult to correct rotations and to extrude teeth. If these limitations are not important in a particular adjunctive case, CAT can be considered. If they are, in nearly all cases adults who are candidates for adjunctive treatment will accept a visible fixed appliance.

![Figure 18-2 A, Brackets placed in the "ideal" position on moderately irregular anchor teeth for molar uprighting. For adjunctive orthodontic treatment, movement of the anchor teeth usually is undesirable, but a straight length of wire will move them as as the brackets are repositioned. B, Brackets placed in the position of maximum convenience, lined up so that a straight length of wire can be placed without moving the anchor teeth. This makes things easier if no movement of the anchor teeth is desired. For adjunctive orthodontic procedures like molar uprighting, we recommend the use of fully adjusted "straight wire" brackets and working archwires that are somewhat smaller than the bracket slot, to reduce unwanted buccolingual movement of anchor teeth even though the brackets are lined up in the other planes of space.](image)

Modern edgewise brackets of the straight wire type (see Chapter 11) are designed for a specific location on an individual tooth. Placing the bracket in its ideal position on each tooth implies that every tooth will be repositioned if necessary to achieve ideal occlusion (Figure 18-2, A). Since adjunctive treatment is concerned with only limited tooth movements, usually it is neither necessary nor desirable to alter the position of every tooth in the arch. For this reason, in a partial fixed appliance for adjunctive treatment, the brackets are placed in an ideal position only on teeth to be moved, and the remaining teeth to be incorporated in the anchor system are bracketed so that the archwire slots are closely aligned (Figure 18-2, B). This allows the anchorage segments of the wire to be engaged passively in the brackets with little bending. Passive engagement of wires to anchor teeth produces minimal disturbance of teeth that are in a physiologically satisfactory position. This important point is illustrated in more detail in the sections on specific treatment procedures that follow.
Effects of Reduced Periodontal Support

Figure 18-3 A, The center of resistance of a single rooted tooth lies approximately six-tenths of the distance between the apex of the tooth and the crest of the alveolar bone. Loss of alveolar bone height, as for the tooth on the right, moves the center of resistance closer to the root apex. B, The magnitude of the tipping moment produced by a force is equal to the force times the distance from the point of force application to the center of resistance. If the center of resistance moves apically, the tipping moment produced by the force \( M_f \) increases, and a larger countervailing moment produced by a couple applied to the tooth \( M_c \) would be necessary to affect bodily movement. This is almost impossible for traditional removable appliances and very difficult with clear aligners even when bonded attachments are added. For all practical purposes, a fixed appliance is required (see Chapter 10 for more detail).

Since patients who need adjunctive orthodontic treatment often have lost alveolar bone to periodontal disease before it was brought under control, the amount of bone support of each tooth is an important special consideration. When bone is lost, the periodontal ligament (PDL) area decreases, and the same force against the crown produces greater pressure in the PDL of a periodontally compromised tooth than a normally supported one. The absolute magnitude of force used to move teeth must be reduced when periodontal support has been lost (see Figure 18-13, p. 645). In addition, the greater the loss of attachment, the smaller the area of supported root and the further apical the center of resistance will become (Figure 18-3). This affects the moments created by forces applied to the crown and the moments needed to control root movement (see Chapter 10). In general terms, tooth movement is quite possible despite bone loss, but lighter forces and relatively larger moments are needed.

Timing and Sequence of Treatment

In the development of any orthodontic treatment plan, the first step is the control of any active dental disease (Figure 18-4). Before any tooth movement, active caries and pulpal pathology must be eliminated, using extractions, restorative procedures, and pulpal or apical treatment as necessary. Endodontically treated teeth respond normally to orthodontic force, providing all residual chronic inflammation has been eliminated. Prior to orthodontics, teeth should be restored with well-placed amalgams or composite resins. Restorations requiring detailed occlusal anatomy should not be placed until any adjunctive orthodontic treatment has been completed, because the occlusion inevitably will be changed. That could necessitate remaking crowns, bridges, or removable partial dentures.

Periodontal disease also must be controlled before any orthodontics begins, because orthodontic tooth movement superimposed on poorly controlled periodontal health can lead to rapid and irreversible breakdown of the periodontal support apparatus. Scaling, curettage (by open flap procedures, if necessary), and gingival grafts should be undertaken as appropriate. Surgical pocket elimination and osseous surgery should be delayed until completion of the orthodontic phase of treatment, because significant soft tissue and bony recontouring occurs during orthodontic tooth movement. Clinical studies have shown that orthodontic treatment of adults with both normal and compromised periodontal tissues can be completed without loss of attachment, providing there is good periodontal therapy both initially and during tooth movement.
The sequence of steps in the treatment of patients requiring adjunctive orthodontics. Orthodontics is used to establish occlusion, but only after disease control has been accomplished, and the occlusion should be stabilized before definitive restorative treatment is carried out.

During this preparatory phase, the patient's enthusiasm for treatment and ability to maintain good overall oral hygiene should be carefully monitored. Adjunctive orthodontics has the potential to do more harm than good in patients who cannot or will not maintain good oral hygiene. If disease can be controlled, however, adjunctive orthodontics can significantly improve the final restorative and periodontal procedures.

**Adjunctive Treatment Procedures**

**Uprighting Posterior Teeth**

**Treatment Planning Considerations**

When a first permanent molar is lost during childhood or adolescence and not replaced, the second molar drifts mesially and the premolars often tip distally and rotate as space opens between them. As the teeth move, the adjacent gingival tissue becomes folded and distorted, forming a plaque-harboring pseudopocket that may be virtually impossible for the patient to clean (Figure 18-5). Repositioning the teeth eliminates this potentially pathologic condition and has the added advantage of simplifying the ultimate restorative procedures.

Figure 18-5 A, Loss of a lower molar can lead to tipping and drifting of adjacent teeth, poor interproximal contacts, poor gingival contour, reduced interradicular bone, and supra-eruption of unopposed teeth. Since the bone contour follows the cementoenamel junction, pseudopockets form adjacent to the tipped teeth. B, Note the loss of alveolar bone in the area where a mandibular first molar was extracted many years previously. Mesial drift and tipping of the second molar has closed half the space. The patient’s posterior crossbite, however, is unrelated to early loss of the molar.
When molar uprighting is planned, a number of interrelated questions must be answered:

- If the third molar is present, should both the second and third molars be uprighted? For many patients, distal positioning of the third molar would move it into a position where good hygiene could not be maintained, or it would not be in functional occlusion. In these circumstances, it is more appropriate to extract the third molar and simply upright the remaining second molar tooth. If both molars are to be uprighted, a significant change in technique is required, as described below.

- How should the tipped teeth be uprighted? By distal crown movement (tipping), which would increase the space available for a bridge pontic or implant (Figure 18-6), or by mesial root movement, which would reduce or even close the edentulous space? As a general rule, treatment by distal tipping of the second molar and a bridge or implant to replace the first molar is preferred. If extensive ridge resorption has already occurred, particularly in the buccolingual dimension, closing the space by mesial movement of a wide molar root into the narrow alveolar ridge will proceed very slowly, and can result in a dehiscence of bone from the root surfaces. If uprighting with space closure is to be done successfully, skeletal anchorage in the form of a temporary implant in the ramus and 2-3 years of comprehensive treatment (as described in the last part of this chapter) are likely to be required.

- Is extrusion of a tipped molar permissible? Uprighting a mesially tipped tooth by tipping it distally, which leaves the root apex in its pretreatment position, also extrudes it. This has the merit of reducing the depth of the pseudopocket found on the mesial surface, and since the attached gingiva follows the cementoenamel junction while the mucogingival junction remains stable, it also increases the width of the keratinized tissue in that area. In addition, if the height of the clinical crown is systematically reduced as uprighting proceeds, the ultimate crown-root length ratio will be improved (Figure 18-7). Unless slight extrusion or crown-height reduction is acceptable, which usually is the case, the patient should be considered to have problems that require comprehensive treatment and treated accordingly.

- Should the premolars be repositioned as part of the treatment? This will depend on the position of these teeth and the restorative plan, but in many cases the answer is yes. It is particularly desirable to close spaces between premolars when uprighting molars, because this will improve both the periodontal prognosis and long-term stability.
Figure 18-7 Uprighting a tipped molar increases the crown height while it reduces the depth of the mesial pocket. Subsequent crown reduction improves the ratio of crown height to supported root length of the molar.

Figure 18-8 Fixed appliance technique for uprighting one molar with a continuous flexible wire. A, Initial bracket alignment is achieved by placing a light flexible wire such as 17 × 25 A-NiTi, from molar to canine; B, Molar uprighting with a continuous M-NiTi wire; C, Progress 1 month later; D, Uprighting essentially completed 2 months later.

In molar uprighting, the treatment time will vary with the type and extent of the tooth movement required. Uprighting a tooth by distal crown tipping proceeds more rapidly than mesial root movement. Failure to eliminate occlusal interferences will prolong treatment. The simplest cases should be completed in 8 to 10 weeks, but uprighting two molars with mesial root movement could easily take 20 to 24 weeks, and the complexity of doing this puts it at the outer limit of adjunctive treatment.
Appliances for Molar Uprighting

A partial fixed appliance to upright tipped molars consists of bonded brackets on the premolars and canine in that quadrant, and either a bonded rectangular tube on the molar or a molar band. A general guideline is that molar bands are best when the periodontal condition allows, which means for all practical purposes they would be used in younger and healthier patients. The greater the degree of periodontal breakdown around the molar to be uprighted, the more a bonded attachment should be considered.

Where premolar and canine brackets should be placed depends on the intended tooth movement and occlusion. If these teeth are to be repositioned, the brackets should be placed in the ideal position at the center of the facial surface of each tooth. However, if the teeth are merely serving as anchor units and no repositioning is planned, then the brackets should be placed in the position of maximum convenience where minimum wire bending will be required to engage a passive archwire (see Figure 18-2).

Uprighting a Single Molar

Distal Crown Tipping

If the molar is only moderately tipped, treatment often can be accomplished with a flexible rectangular wire. The best choice is 17 × 25 A-NiTi that delivers approximately 100 gm of force (see Chapter 10). With this modern material, a single wire may complete the necessary uprighting (Figure 18-8). A braided rectangular steel wire also can be used but is more likely to require removal and reshaping. It is important to relieve the occlusion as the tooth tips upright. Failure to do this may cause excessive tooth mobility and increases treatment time.

Figure 18-9 Uprighting with an auxiliary spring. A, If the relative alignment of the molar precludes extending the stabilizing segment into the molar bracket, then a rigid stabilizing wire, 19 × 25 stainless steel, is placed in the premolars and canine only (often with the brackets positioned so this wire is passive—see Figure 18-3). The mesial arm of the uprighting spring lies in the vestibule before engagement, and the spring is activated by lifting the mesial arm and hooking it over a stabilizing wire in the canine and premolar brackets. B, Auxiliary uprighting spring to molar just after initial placement. Note the helix bent into the steel wire that forms the spring, to provide better spring qualities. C, Because the force is applied to the facial surface of the teeth, an auxiliary uprighting spring tends not only to extrude the molar but also to roll it lingually, while intruding the premolars and flaring them buccally. To counteract this side effect, the uprighting spring should be curved buccolingually so that when it is placed into the molar tube, the hook would lie lingually to the archwire prior to activation (dotted line). D, Better control of anchorage, with either a continuous wire or an auxiliary spring, is obtained when a canine-to-canine stabilizing wire is bonded on the lingual surface of these teeth.

If the molar is severely tipped, a continuous wire that uprights the molar will also tip the second premolar distally, which is undesirable. It is better therefore to carry out the bulk of the uprighting using a sectional uprighting spring (Figure 18-9). After preliminary alignment of the anchor teeth if necessary, stiff rectangular wire (19 × 25 steel) maintains the relationship of the teeth in the anchor segment, and an auxiliary spring is placed in the molar auxiliary tube. The uprighting spring is formed from either 17 × 25 beta-Ti wire without a helical loop, or 17 × 25 steel wire with
a loop added to provide more springiness. The mesial arm of the helical spring should be adjusted to lie passively in the vestibule and upon activation should hook over the archwire in the stabilizing segment. It is important to position the hook so that it is free to slide distally as the molar uprights. In addition, a slight lingual bend placed in the uprighting spring is needed to counteract the forces that tend to tip the anchor teeth buccally and the molar lingually (Figure 18-9, C).

**Mesial Root Movement**

If mesial root movement is desired, an alternative treatment approach is indicated (Figure 18-10). After initial alignment of the anchor teeth with a light flexible wire, a single "T-loop" sectional archwire of 17 × 25 stainless steel or 19 × 25 beta-Ti wire is adapted to fit passively into the brackets on the anchor teeth and gabled at the T to exert an uprighting force on the molar. Insertion into the molar can be from the mesial or distal. If the treatment plan calls for maintaining or closing rather than increasing the pontic space, the distal end of the archwire should be pulled distally through the molar tube, opening the T-loop by 1 to 2 mm, and then bent sharply gingivally to maintain this opening. This activation provides a mesial force on the molar that counteracts distal crown tipping while the tooth uprights (Figure 18-10, D). If opening the space is desired, the end of the wire is not bent over so the tooth can slide distally along it.

The T-loop appliance also is indicated if the molar to be uprighted is severely tipped but has no occlusal antagonist. In that circumstance, a T-loop minimizes the extrusion that accompanies uprighting, which can be excessive with the other methods when there is no antagonist.

**Final Positioning of Molar and Premolars**

Once molar uprighting has been almost accomplished, often it is desirable to increase the available pontic space and close open contacts in the anterior segment. This is done best using a relatively stiff base wire, with a compressed coil spring threaded over the wire to produce the required force system. With 22-slot brackets, the base wire should be 18 mil round or 17 × 25 rectangular steel wire, which should engage the anchor teeth and the uprighted molar more or less passively. The wire should extend through the molar tube, projecting about 1 mm beyond the distal. An open coil steel spring (.009 wire, .030 lumen) is cut so that it is 1-2 mm longer than the space, slipped over the base wire (Figure 18-11), and compressed between the molar and distal premolar. It should exert a force of approximately 150 gm to move the premolars mesially while continuing to tip the molar distally. The coil spring can be reactivated without removing it by compressing the spring and adding a split spacer to maintain the compression (Figure 18-11, B).
Uprighting Two Molars in the Same Quadrant

Because the resistance offered when uprighting two molars is considerable, only small amounts of space closure should be attempted. The goal should be a combination of modest lingual crown movement and distal crown tipping, which typically would leave space for a premolar-sized implant or pontic. In the lower arch, a bonded canine-to-canine lingual stabilizing wire (which is similar to a bonded retainer—see Chapter 17) is needed to control the position of the anterior teeth (see Figure 18-9). Trying to upright both the second and third molars bilaterally at the same time is not a good idea—significant movement of the anchor teeth is inevitable.

Figure 18-11 A, Compressed coil spring on a round wire (usually 18 mil steel) may be used to complete molar uprighting while closing remaining spaces in the premolar region. B, The coil spring may be reactivated by compressing it against a split spacer crimped over the archwire.

Figure 18-12 A molar that has been uprighted is unstable and must be maintained in its new position until a fixed bridge or implant is placed to stabilize it. There are two ways to provide temporary stabilization: A, An extracoronal splint using 19 × 25 steel wire engaging the brackets passively; B, An intracoronal splint (often called an A-splint) that is bonded in shallow preparations in the proximal enamel with composite resin (also see Figure 17-14). This causes minimal tissue disturbance. The intracoronal splint is preferred, particularly if retention is to be continued for more than a few weeks.

When both the second and third molars are to be uprighted, the third molar should carry a single rectangular tube and the second molar a bracket. Since the second molar is usually more severely tipped than the third molar, increased flexibility of the wire mesial and distal to the second molar is required. The best approach is to use a modern highly flexible wire initially, and 17 × 25 A-NiTi usually is a good choice. Excessive mobility of the teeth can result from failure to reduce occlusal interferences.
Retention
After molar uprighting, the teeth are in an unstable position until the prosthesis that provides the long-term retention is placed. Long delays in making the final prosthesis should be avoided if possible. As a general guideline, a fixed bridge can and should be placed within 6 weeks after uprighting is completed. Especially if an implant is planned, there may be a considerable delay while a bone graft heals and the implant becomes integrated. If retention is needed for more than a few weeks, the preferred approach is an intracoronal wire splint (19 × 25 or heavier steel wire), bonded into shallow preparations in the abutment teeth (Figure 18-12). This type of splint causes little gingival irritation and can be left in place for a considerable period, but it would have to be removed and rebonded to allow bone grafting and implant surgery.

Crossbite Correction
Posterior crossbites frequently are corrected using "through the bite" elastics from a conveniently placed tooth in the opposing arch, which moves both the upper and lower tooth (Figure 18-13, A). This tips the teeth into the correct occlusion but also tends to extrude them. For this reason, elastics must be used with caution to correct posterior crossbites in adults, because the extrusion can change occlusal relationships throughout the mouth. One way to obtain more movement of a maxillary tooth than its antagonist in the lower arch is to have several teeth in the lower arch stabilized by a heavy archwire segment (Figure 18-13, B-E). Of course, the same approach could be used in reverse to produce more movement of a mandibular tooth. If a mesially tipped lower molar also is in buccal crossbite, an auxiliary uprighting spring can be contoured to help move it lingually (see Figure 18-36). If a deep overbite exists on the teeth in crossbite, correction will be much easier if a temporary bite plane that frees the occlusion is added. This bite plane should be carefully constructed to contact the occlusal surfaces of all teeth to prevent any supereruption during treatment.

Establishing a good overbite relationship is the key to maintaining crossbite correction. Crown reconstruction can be used to provide positive occlusal indexing, while eliminating any balancing interferences from the lingual cusps of posterior teeth.

If an anterior crossbite is due only to a displaced tooth and if correcting it requires only tipping (as perhaps in the case of a maxillary incisor that was tipped lingually into crossbite), then a removable appliance or clear aligner may be used to tip the tooth into a normal position. However, when using either type of removable appliance, tipping a tooth facially or lingually also produces a vertical change in occlusal level (Figure 18-14). Tipping maxillary incisors labially to correct anterior crossbite nearly always produces an apparent intrusion and a reduction in overbite. This can present a problem during retention, since a positive overbite serves to retain the crossbite correction. A fixed appliance generally is necessary for vertical control in correction of anterior crossbites.

Forced Eruption
Treatment Planning
For teeth with defects in or adjacent to the cervical third of the root, controlled extrusion can be an excellent alternative to extensive crown-lengthening surgery. Extruding the tooth can allow isolation under rubber dam for endodontic therapy when it would not be possible otherwise. Forced eruption also allows crown margins to be placed on sound tooth structure while maintaining a uniform gingival contour that provides improved esthetics (Figure 18-15). In addition, the alveolar bone height is not compromised, the apparent crown length is maintained, and the bony support of adjacent teeth is not compromised. As the tooth is extruded, the attached gingiva should follow the cementoenamel junction. This returns the width of the attached gingiva to its original level. However, it usually is necessary to perform some limited recontouring of the gingiva, and perhaps of the bone, to produce a contour even with the adjacent teeth and a proper biologic width between bone and depth of sulcus.
Figure 18-13 A, "Through the bite" or cross elastics produce both horizontal and vertical forces and will extrude the teeth while moving them buccolingually. If these elastics are used to correct posterior crossbite in adults, care must be taken not to open the bite anteriorly too much. Cross elastics are rarely indicated for an anterior crossbite. B, Buccal crossbite of the second molars in a patient at age 50 who had lost the mandibular first molar years previously. The lower second molar had tipped mesially and lingually. C, The standard orthodontic appliance for uprighting a lower molar was used, consisting of a band on the mandibular second molar, a bonded canine-to-canine mandibular lingual wire to augment anchorage, and bonded brackets on the facial of the premolars and canine. In addition, a lingual cleat was placed on the lower band, and a band with a facial hook was placed on the maxillary second molar, so that cross elastics could be worn. D, The molar uprighting was completed after the crossbite was corrected. E, The completed bridge in place. This is classic adjunctive orthodontics. The anterior deep bite and incisor alignment were not problems for this patient and were not corrected.

As a general rule, endodontic therapy should be completed before extrusion of the root begins. For some patients, however, the orthodontic movement must be completed before definitive endodontic procedures, because one purpose of extrusion may be to provide better access for endodontic and restorative procedures. If so, preliminary endodontic treatment to relieve symptoms is done initially, and the tooth is maintained with a temporary root filling or other palliative treatment until it has been moved to a better position.

The distance the tooth should be extruded is determined by three things: (1) the location of the defect (fracture line, root perforation, etc.); (2) space to place the margin of the restoration so that it is not at the base of the gingival sulcus (typically, 1 mm is needed); and (3) an allowance for the biological width of the gingival attachment (about 2 mm). Thus if a fracture is at the height of the alveolar crest, the tooth should be extruded about 3 mm; if it is 2 mm below the crest, 5 mm of extrusion ideally would be needed. The crown-to-root ratio at the end of treatment should be 1 : 1 or better. A tooth with a poorer ratio can be maintained only by splinting it to adjacent teeth.

Isolated one- or two-wall vertical pockets pose a particular esthetic problem if they occur in the anterior region of the mouth. Surgical correction may be contraindicated simply on esthetic grounds. Forced eruption of such teeth, with concomitant crown reduction, can improve the periodontal condition while maintaining excellent esthetics.

In general, extrusion can be as rapid as 1 mm per week without damage to the PDL, so 3 to 6 weeks is sufficient for almost any patient. Too much force, and too rapid a rate of movement, runs the risk of tissue damage and ankylosis.
Orthodontic Technique

Since extrusion is the tooth movement that occurs most readily and intrusion the movement that occurs least readily, ample anchorage is usually available from adjacent teeth. The appliance needs to be quite rigid over the anchor teeth, and flexible where it attaches to the tooth that is being extruded. A continuous flexible archwire (see Figure 18-15) produces the desired extrusion but must be managed carefully because it also tends to tip the adjacent teeth toward the tooth being extruded, reducing the space for subsequent restorations and disturbing the interproximal contacts within the arch (Figure 18-16, A). A flexible cantilever spring to extrude a tooth (Figure 18-16, B), or a rigid stabilizing wire and an auxiliary elastomeric module or spring for extrusion (Figure 18-16, C) provide better control.

Two methods are suggested for extrusion in uncomplicated cases. The first employs a stabilizing wire, 19 × 25 or 21 × 25 stainless steel, bonded directly to the facial surface of the adjacent teeth (Figure 18-17). A post and core with temporary crown and pin is placed on the tooth to be extruded, and an elastomeric module is used to extrude the tooth. This appliance is simple and provides excellent control of anchor teeth, but better control can be obtained when orthodontic brackets are used.
In Figure 18-16 A, although a straight orthodontic wire activated apically will produce an extrusive force on a tooth, it will also cause the teeth on either side to tip toward each other, reducing the space available for the extruding tooth. B, A modified T-loop in a rectangular wire (17 × 25 steel in 18 slot brackets, 19 × 25 beta-Ti in 22 slot) will extrude a tooth while controlling mesio-distal tipping. C, Extrusion also can be done without conventional orthodontic attachments, by bonding a 19 × 25 steel stabilizing wire directly to the facial surface of adjacent teeth. An elastomeric module is stretched between the stabilizing wire and a pin placed directly into the crown of the tooth to be extruded. If a temporary crown is used for better esthetics while the extrusion is being done, it must be progressively cut away to make the tooth movement possible. (C, courtesy Dr. L. Osterle.)

The alternative is to bond brackets to the anchor teeth, bond an attachment (often a button rather than a bracket) to the tooth to be extruded, and use interarch elastics (Figure 18-18) or a flexible archwire (Figure 18-19). If the buccal surface of the tooth to be extruded is intact, a bracket should be bonded as far gingivally as possible.

Figure 18-17 Possible approaches to Extrusion of a single tooth can be done without conventional orthodontic attachments, by bonding a 19 × 25 steel stabilizing wire directly to the facial surface of adjacent teeth. A, An elastomeric module is stretched between the stabilizing wire and a pin placed directly into the crown of the tooth to be extruded, in this case a fractured maxillary premolar. B, The same technique can be used to extrude an incisor. A temporary restoration placed on the tooth while it is being extruded needs to be reduced at frequent intervals. (Courtesy Dr. L. Osterle.)

If the crown of a posterior tooth is hopelessly destroyed, an orthodontic band with a bracket usually can be placed over the remaining root surface. An orthodontic band has the benefit of helping isolation procedures during emergency endodontic treatment. Once endodontic treatment is completed, a pin in the tooth can be used for the attachment, and a temporary crown can be placed if needed for esthetics. Adjacent teeth are bonded to serve as the anchor unit. With any technique for forced eruption, the patient must be seen every 1 to 2 weeks to reduce the occlusal surface of the tooth being extruded if this is needed (see Figure 18-17), control inflammation and monitor progress. After active tooth movement has been completed, at least 3 but not more than 6 weeks of stabilization is needed to allow reorganization of the periodontal ligament. If periodontal surgery is needed to recontour the alveolar bone and/or reposition the gingiva, this can be done 1 month after completion of the extrusion. As with molar uprighting, it is better to complete the definitive prosthetic treatment without extensive delay.
Alignment of Anterior Teeth

Anterior Diastema Closure and Space Redistribution

The major indication for adjunctive orthodontic treatment to correct malaligned anterior teeth is preparation for build-ups, veneers or implants to improve the appearance of the maxillary incisor teeth. The most frequent problem is a maxillary central diastema, often further complicated by irregular spacing related to small or missing lateral incisors. A "diagnostic setup" is very helpful in planning the correction of such problems. For this procedure, the study casts are duplicated and the malaligned teeth are carefully cut from the model, repositioned and the teeth are then waxed back onto the cast in a new position. If digital casts are available, a modern alternative is to do this on a computer screen (see Figure 14-1), and this is part of routine treatment planning when a sequence of clear aligners will be used in comprehensive treatment (see below). This allows evaluation of the feasibility of the orthodontic treatment in light of the crown and root movements required, the anchorage available, the periodontal support for each tooth, and the possible occlusal interferences.

There are two possible orthodontic techniques: a partial fixed appliance, typically with bonded brackets on the maxillary incisors and a bonded tube on the first molars for additional anchorage control; or a sequence of clear aligners. With a fixed appliance, initial alignment is carried out using a light wire such as 16 mil A-NiTi or 17.5 mil braided steel. This wire is replaced, after the teeth are aligned, with a 16 or 18 mil round steel wire along which the teeth are repositioned using elastomeric modules or coil springs (Figure 18-20). There is always a tendency for the space to reopen after any degree of diastema closure. Bonding a flexible wire on the lingual of the incisors as a semi-permanent retainer is recommended (see Figure 17-12).
An alternative is the use of a sequence of clear aligners. These are available commercially in two ways: (1) for modest amounts of tooth movement, aligners made by re-setting the teeth on dental casts that can be reshaped by the doctor (see Figure 11-12) and (2) for more extensive tooth movement, a set of 15-50 aligners fabricated on stereolithographic models created from computer models of the projected tooth movement (Invisalign, OrthoClear). In adjunctive treatment, the first method is potentially quite useful. The second method, discussed in more detail in the latter part of this chapter, is almost prohibitively expensive unless comprehensive treatment is planned.

Figure 18-20 If spacing of maxillary incisors is related to small teeth and a tooth-size discrepancy, composite build-ups are an excellent solution, but satisfactory esthetics may require redistribution of the space before the restorations are placed, as in this patient who was concerned about his large central diastema. A and B, Before treatment, age 48; C and D, Redistribution of the space using a fixed appliance with coil springs on a 16 mil steel archwire, immediately before removal of the orthodontic appliance and placement of the restorations (to be done the same day). For this patient, a 17.5 mil multistrand wire was used for initial alignment, before the coil springs were placed; E and F, Completed restorations (composite build-ups). G, Note the retainer of bonded 21.5 mil multistrand wire on the lingual of the central incisors to prevent partial reopening of the midline space. Surgical revision of the frenum was not performed, partially in deference to the patient’s age. H, Appearance on smile before and I, after treatment.

Alignment of Crowded, Rotated, and Displaced Incisors
As a rule, spacing is the problem when maxillary incisors need realignment to facilitate other treatment. Crowding usually is the problem when alignment of lower incisors is considered, to provide access for restorations, achieve better occlusion, or enable the patient to maintain the teeth. In some cases, alignment of incisors in both arches must be considered. The key question is whether the crowding should be resolved by expanding the arch, removing some interproximal enamel from each tooth to provide space, or removing one lower incisor.
Figure 18-21 The decision to extract a damaged lower incisor in an adult with crowding and use the space to align the remaining teeth, or to align the teeth and restore the damaged one, has an esthetic component because the lower incisors are visible on smile in older individuals. In this patient, aligning the lower incisors without extraction would also require aligning the upper incisors—but this expansion would increase lip support and improve the overall facial appearance as well as the dental appearance. A, Smile before treatment, after loss of one corner of the lower right central incisor; B, Mandibular occlusal view; C, Frontal view. Note the moderately deep bite and lack of overjet. The restorative dentist sought orthodontic consultation, thinking that extraction of the damaged tooth might be the best plan. The patient wanted the best esthetic result, and accepted a period of treatment with a fixed appliance on both arches, after which the incisor would be restored. The orthodontic alignment required 5 months. D, Mandibular occlusal view after alignment; E, Frontal view; F, Smile after restoration was completed.

Expansion of a crowded incisor segment can be done with clear aligners, but if only the lower arch is to be treated, the esthetics of the appliance is not a consideration, and a partial fixed appliance is more efficient and cost-effective.
A segment of A-NiTi wire, with stops to make it slightly advanced, usually is the best way to bring the teeth into alignment. For root positioning, this should be succeeded by a segment of rectangular NiTi wire. Stripping the contact points of the teeth to remove enamel can provide space for alignment of mildly irregular lower incisors, and either a fixed appliance or a clear aligner sequence can provide the tooth movement. This should be undertaken with caution, however, because it may have an undesirable effect on overjet, overbite, posterior intercuspation, and esthetics. In severe crowding, removing one lower incisor and using the space to align the other three incisors can produce a satisfactory result (Figure 18-22). The treatment time and difficulty, whatever the type of appliance, put this at or across the border of comprehensive treatment. Neither stripping nor incisor extraction should be undertaken without a diagnostic set-up to verify feasibility. Remember that stretched gingival fibers are a potent force for relapse after rotations have been corrected, and that good long-term stability may require a fiberotomy (see Chapter 16). Whether clear aligners or a fixed appliance was used, retention is necessary until restorative or other treatment is completed. This can be the final aligner in a sequence, a molded thermoplastic retainer after a fixed appliance is removed, a canine-to-canine clip retainer or a bonded fixed retainer (see Chapter 17).

Figure 18-22 This 24-year-old patient had a congenitally missing mandibular right lateral incisor and a retained but failing primary incisor. A, Frontal view; B, Maxillary occlusal. Note the rotation of the maxillary right canine; C, Mandibular occlusal. The plan was extraction of the primary incisor and closure of the extraction site, using a series of Invisalign aligners and bonded attachments to produce the necessary rotation and root movement. Before treatment began, air-rotor stripping of the maxillary posterior quadrants was done to reduce the tooth-size discrepancy. D, Note the hard-to-see bonded attachments on the maxillary right canine and incisors, and the mandibular right canine and central incisor. The original plan called for 13 upper and 15 lower aligners, plus 3 over-correction aligners. E, F, After 8 aligners it was noted that the maxillary right canine was not tracking, and an elastic to additional bonded attachments was used along with the aligner to further rotate it. New records were taken, and 4 upper and 5 lower revision aligners, with 3 revision over-correction aligners, were fabricated. G to I, Completion of treatment. A bonded canine-to-canine mandibular retainer was used, and the final maxillary aligner was continued at night as the maxillary retainer. J, Panoramic radiograph at the completion of treatment. Total treatment time was 19 months (which includes 2 months waiting for revision aligners). (Courtesy Dr. W. Gierie.)