Managing Complex Orthodontic Problems: The Use of Implants for Anchorage

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Today implants are commonly used to replace missing teeth in partially edentulous adult orthodontic patients. Because these patients are missing teeth, orthodontic mechanics may be complicated or often impossible because of insufficient anchorage. In these situations, it may be feasible to use the implant initially as an orthodontic anchor to facilitate complex tooth movement and secondarily as an abutment for a crown or fixed prosthesis. This article will discuss the ramifications and requirements for using implants as anchors and abutments in adult orthodontic patients. (Semin Orthod 1996;2:1-8.) ***Copyright © 1996 by W.B. Saunders Company***

During orthodontic treatment, tooth movement is reciprocal and each tooth acts as an anchor facilitating movement of adjacent teeth. Therefore, all teeth move relative to one another. Absolute or complete anchorage is usually impossible unless an ankylosed tooth is used as an anchor unit. The lack of complete anchorage is usually not a problem because most patients have full dentitions. However, adult patients are often partially edentulous. When a patient is missing several teeth, anchorage for tooth movement decreases. In some patients, certain types of tooth movement are impossible. Today, many partially edentulous patients are being restored with implants as abutments for fixed bridges. If orthodontic treatment is needed for these patients, the implants may be used initially as anchors for tooth movement and later as abutments for fixed restorations.

Several studies have documented the use of implants for orthopedic anchorage.[1-3] However, only a few reports have noted the use of implants to anchor tooth movement.[4-6] With an immobile implant in the bone, several types of tooth movement are possible. A tooth can be pulled toward the implant, pushed away from the implant, as well as intruded, or extruded relative to the level of the implant. This article will document the use of implants to accomplish these three types of tooth movement. In each situation, careful planning was necessary so that the implants could be used as abutments for fixed restorations after orthodontics. The treatment of each of these patients will be described initially, and then the timing and location of implant placement as well as other critical issues will be discussed.

Case Reports

Patient RB

This patient had a significant dental and skeletal deformity. Although she was only 30 years old, several teeth had been extracted because of significant decay. The lack of teeth was complicated by a significant Class III malocclusion with mandibular hyperplasia and maxillary hypoplasia (Fig 1). After consultation with a team of specialists, it was decided that this patient's treatment would involve orthodontic alignment and positioning of abutment teeth, uprighting of the third molars, orthognathic surgery to correct the skeletal deformity, and full mouth reconstruction with fixed bridges replacing the missing teeth. As part of the treatment plan, it was necessary to upright and intrude the mandibular third molars. To accomplish this tooth movement, titanium implants were placed bilaterally

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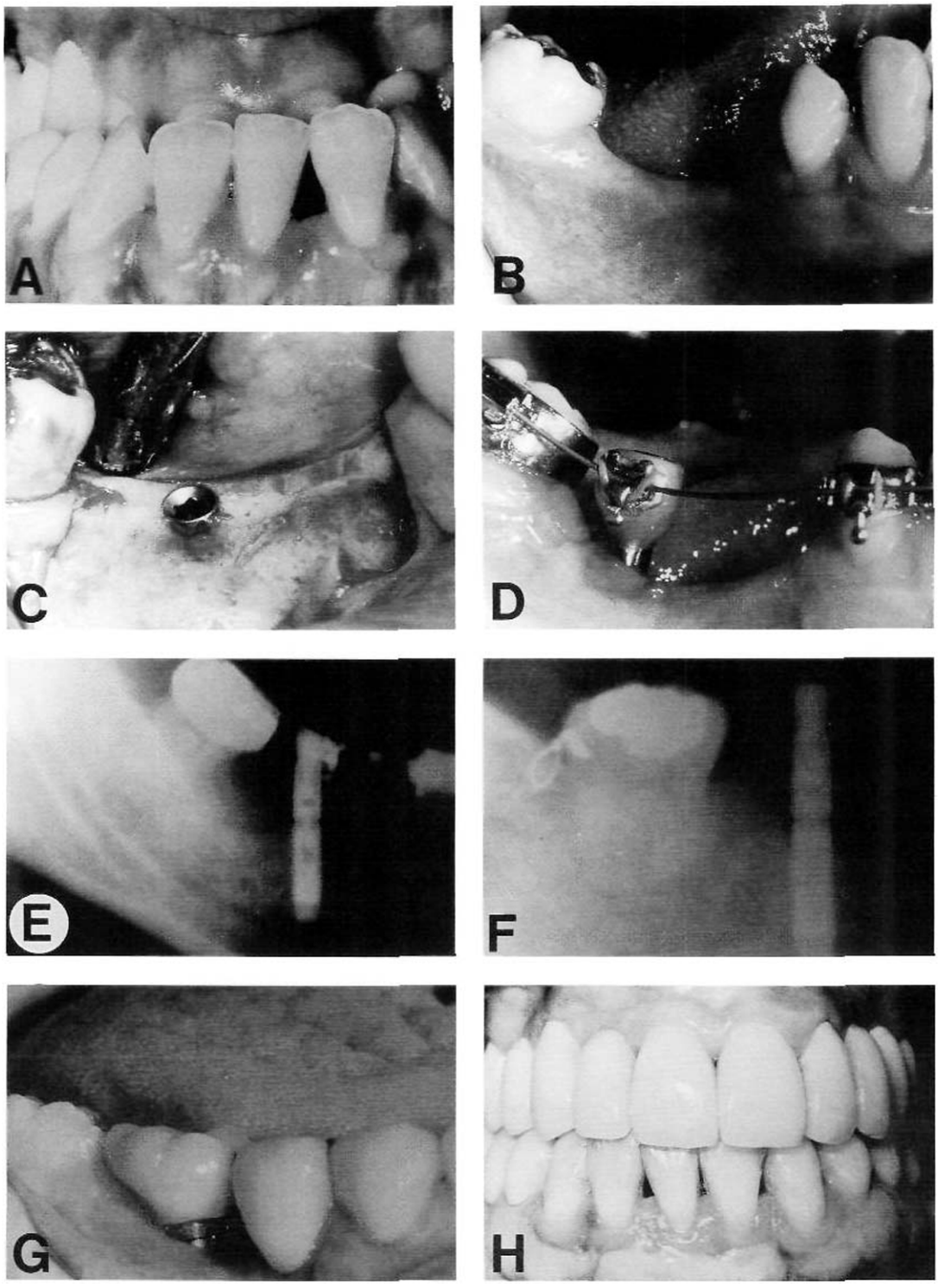

Figure 1. Patient RB had a significant Class III dental and skeletal malrelationship with an anterior crossbite (A) and several missing teeth. The mandibular right first and second molars were missing and the third molar had supererupted beyond the occlusal plane (B). A titanium implant was strategically placed mesial to the mandibular right third molar (C), and after 6 months, an abutment was placed, temporarily restored, and used as an orthodontic anchor to intrude the mandibular third molar (D). Pretreatment and posttreatment radiographs (E, F), show the significant intrusion that occurred using the implant as an anchor for the orthodontic force. After orthodontic treatment, the implant was used as an abutment for a three-unit bridge (G), as a part of her overall reconstruction. The use of the implant was critical to accomplish significant tooth movement and assist in rehabilitating this patient (H).

in the mandible. After being used for orthodontic anchorage, the implants would be used as abutments for fixed bridges.

To determine proper implant location, a diagnostic wax set-up was constructed to predetermine the widths of the pontics and molar abutments for each of the eventual mandibular three-unit bridges. From this set-up, the position of the implant could be determined by measuring the distance from the distal of the mandibular first premolars. This distance was transferred intraorally to locate the position of the implant. The implants were positioned parallel to the long axis of the roots of the first premolars (Fig 1). The implants were buried in the bone for 6 months.

At that point, the implants were uncovered, and abutments were placed into each fixture. Composite crowns were constructed on the abutments to facilitate placement of an orthodontic bracket. The height of the composite bracket was level with the occlusal plane of the premolar. Using the implants as anchors, flexible nickel titanium wire was inserted into the third molars (Fig 1). Over a period of 8 months, the third molars were uprighted and intruded so that the occlusal surfaces of the molars were level with the occlusal surfaces of the abutments (Fig 1). The amount of molar intrusion was verified by superimposition of pretreatment and posttreatment cephalometric radiographs. After orthodontic appliance removal, the implants were prepared and used as abutments for fixed bridges between the implant and premolar.

Patient PS

This 46-year-old patient was missing several posterior mandibular teeth. She had moderate crowding of the mandibular incisors. The maxillary and mandibular incisors were contacting in an end-to-end relationship (Fig 2). One of the primary objectives for this patient's treatment was to retract the mandibular incisors lingually during orthodontics. However, this would have been difficult because she only had two remaining mandibular molars (Fig 2). The mandibular right second molar had a Class III furcation defect and significant mesial bone loss. The mandibular left third molar was positioned above the occlusal plane and would have been difficult to use as an anchor to retract the mandibular anterior teeth.

It was decided that the molars would be extracted and implants would be placed in the posterior alveolus and used as anchors to retract the incisors. In this situation, a diagnostic wax set-up was required to predetermine the location of the implants. The mandibular premolars would move toward the implants during orthodontics. Therefore, it was necessary to simulate the eventual position of these teeth, so that the implants could be placed far enough distally to permit sufficient pontic space after retraction of the incisors. During construction of the set-up, the maxillary arch served as a guide. Initially the maxillary incisors were aligned and their original anteroposterior position was maintained. The mandibular anterior teeth were positioned with normal overbite and overjet. The posterior teeth were positioned to interdigitate correctly with the maxillary molars and premolars. Space was apportioned for a pontic and the final position of the implant abutment could be determined (Fig 2).

The implant position was transferred to the original model, so that the exact location of the implant could be identified before orthodontic treatment. Implants were placed bilaterally in these predetermined locations and were buried for 6 months. After uncovering, abutments were placed into each fixture and acrylic provisional crowns were placed on the abutments. After bracketing, elastomeric chains were used to retract the anterior teeth using the implants as anchors (Fig 2). The teeth were retracted until the overbite and overjet had been corrected. Superimposition of pretreatment and posttreatment cephalometric radiographs showed that the mandibular premolars had been retracted 4 mm, and the incisors were retracted 2.5 mm. This movement would not have been possible without the implants as anchors.

Patient SW

This 50-year-old woman had several posterior teeth missing. On the right side, the maxillary molars and premolars had erupted into the mandibular edentulous space (Fig 3). As a result the patient had insufficient interarch space for mandibular pontics. The primary objective of treatment for this patient was to intrude the overerupted teeth. It would have been impossible to use the adjacent canine and second

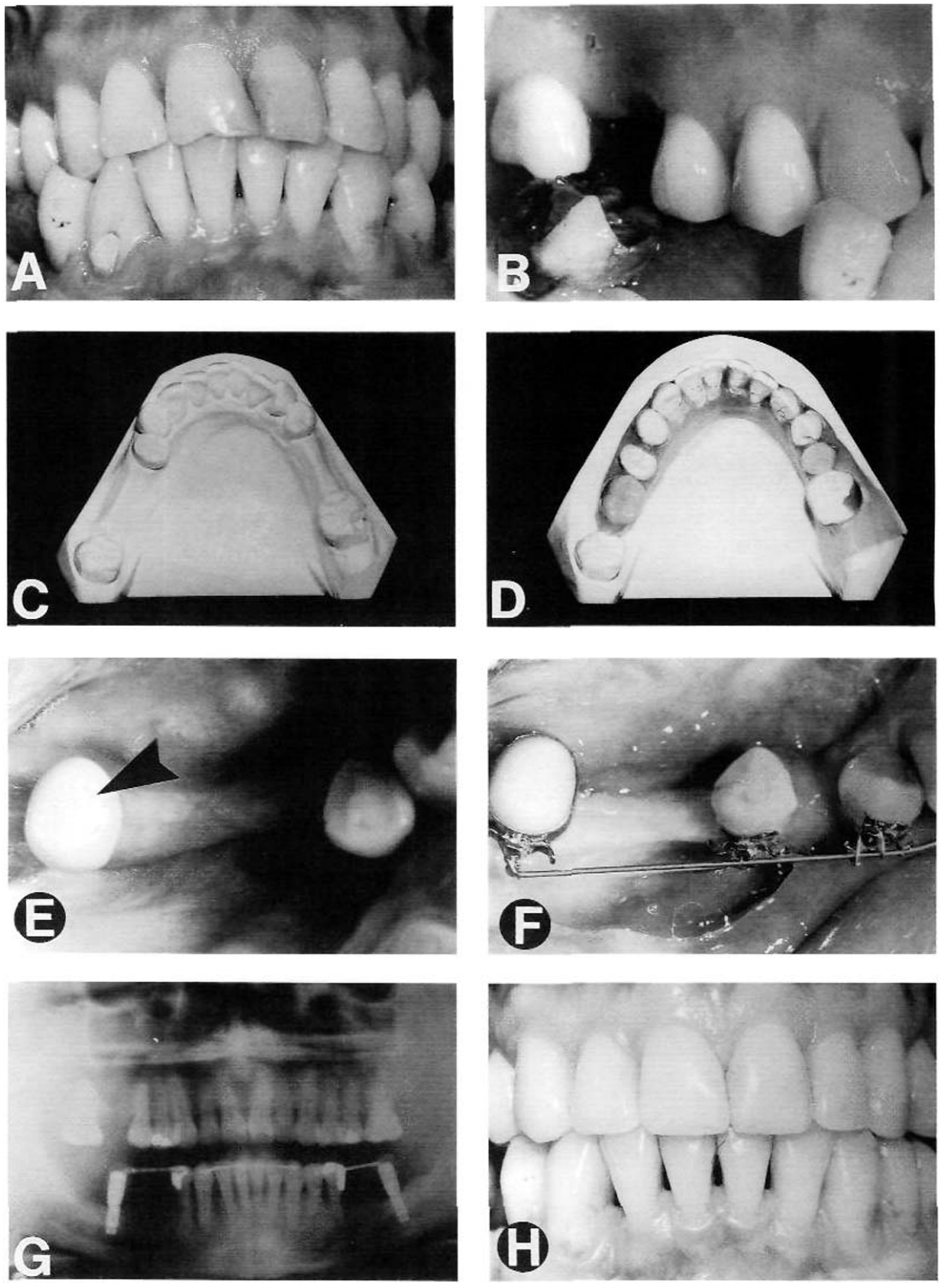

Figure 2. Patient PS had had several posterior teeth extracted because of caries and periodontal disease (A and B). The incisors were in an end-to-end relationship and needed to be retracted. The remaining mandibular posterior teeth were poor candidates for orthodontic anchorage (C). A diagnostic set-up was constructed to determine the proper placement of bilateral mandibular implants to be used as anchors to retract the mandibular incisors (D). The implants were placed and after 6 months were restored with provisional crowns (E, arrow). The implant was used to retract the premolars and incisors (F). In this patient, the implants were a critical adjunct to support retraction of the mandibular incisors and improve the patient's occlusion (G and H).

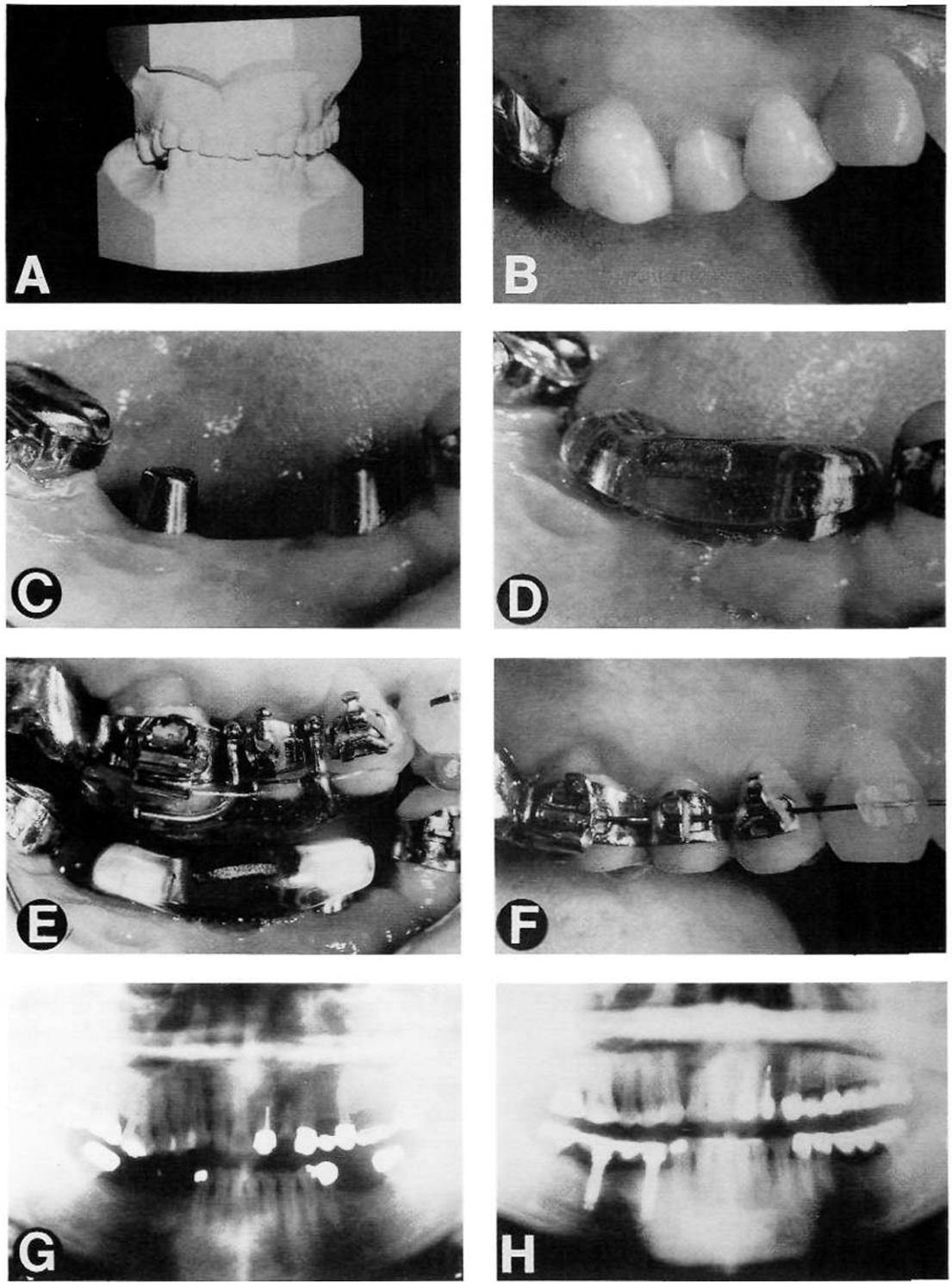

Figure 3. Patient SW had been missing the mandibular right first and second premolars and first molar for many years. The maxillary right posterior teeth had supererupted into the mandibular edentulous space (A, B). Implants were placed in the mandibular edentulous space (C), and a plastic stage with a samarium-cobalt magnet was embedded into the occlusal surface (D). A removable plastic stent with a samarium-cobalt magnet was placed segmentally over the maxillary right first and second premolars and first molar (E). Over a 6-month period, the magnetic force intruded the maxillary posterior teeth using the implants as an immobile anchor (F). Pretreatment and posttreatment panoramic radiographs (G, H), show the significant tooth intrusion and leveling of the maxillary right posterior occlusal plane and the use of the implants as abutments for a fixed bridge after the orthodontic treatment had been completed.

molar as anchors to intrude the overerupted premolars and first molar.

The restorative plan for this patient involved an implant-supported three-unit bridge in the mandibular arch. It was decided to place the implants before orthodontics and use the fixtures as anchorage to intrude the overerupted maxillary teeth. The implants were placed in the bone and buried for 6 months (Fig 3). After uncovering the implants, abutments were placed on both the fixtures. To intrude the opposing teeth, a repelling magnetic force would be applied from the implants.

A plastic stage was placed over the mandibular abutments. A samarium-cobalt magnet was placed in the occlusal surface of the plastic stage between the implants (Fig 3). A removable segmental stent containing a magnet was placed over the maxillary teeth. When the magnets were brought into contact (Fig 3), the repelling force could not move the implants, but would provide an intrusive force to the maxillary teeth.

To achieve the maximum magnetic force, the patient wore an acrylic splint that contacted the remaining teeth during sleep. The occlusal surface of the splint was adjusted so the magnets were in contact. The patient wore intermaxillary elastics during sleep to keep the teeth together and the magnets in contact. As the molars intruded, the splint was adjusted.

Over an 8-month period, a cephalometric superimposition showed that the maxillary first molar and second premolar had intruded about 3 mm. An overall superimposition of the same radiographs showed that there was no vertical change in the position of menton. After orthodontic treatment had been completed, the implants were used as abutments for a three-unit bridge (Fig 3).

Discussion

Several factors are necessary to ensure success when using implants as anchors to move adjacent teeth. First and foremost is the planning process. It is impossible to accomplish this type of interdisciplinary treatment without good communication between all members of the team. In most orthodontic patients, interdisciplinary planning is not necessary. However, in the partially edentulous patient, it is mandatory. Input from the restorative dentist, periodontist, oral and maxillofacial surgeon, and orthodontist will help to formulate the proper objectives, treatment sequence, and assure the quality of the final result. This is especially important when implants are being used. By carefully determining the proper position of the implant before orthodontic therapy, it may be used as an anchor for tooth movement, and also as an abutment for a fixed restoration following the completion of orthodontic therapy.

The location of the implant before orthodontic therapy can often be confusing. This is especially true if the teeth are moving toward or way from the implant during orthodontics. In these situations, the outcome or final result must be predetermined to achieve the proper implant location and the correct size of the crowns and pontics on the implant-supported prosthesis. This precise positioning of the implant requires the construction of a pretreatment diagnostic wax set-up.[7-8]

When constructing the set-up, the orthodontist must realistically position the teeth in wax simulating the outcome of the proposed orthodontic mechanics. After the projected position of the implant has been determined, that information must be transferred to the original model, because the implants are generally placed before orthodontic treatment begins.[7,8] A plastic placement guide is constructed and used by the clinician to determine proper implant location intraorally. The placement guide is based on information derived from the diagnostic wax set-up. Therefore, it is necessary to construct the set-up casts from an exact duplicate of the tooth and base portions of the original dental casts. The bases are used as a reference for the proposed position of the implant. The diagnostic wax set-up acts as a blueprint for proper implant placement.

Another crucial step in the process is to determine the appropriate time for placing the implant. In most situations, the implant is placed before the orthodontic treatment begins. However, occasionally the implants will be placed during orthodontic treatment. These are special situations, when tooth movement on either side of the implant may be unpredictable. In those patients, it is best to begin the orthodontic treatment, align the teeth, and then make a set of progress dental casts and construct the diagnostic wax set-up on these casts.

Another issue related to timing is the age of the patient. Previous studies in experimental animals have shown that implants will not erupt.[9,10] Teeth will continue to erupt if a patient is growing. Therefore, a significant vertical discrepancy could occur between implants and natural teeth if the patient is still growing. Implants should not be placed in growing individuals. In young patients, serial cephalometric radiographs are used to determine the appropriate timing for implant placement. If no change in vertical facial development is detected, by comparing two cephalometric radiographs taken 12 months apart, then the implants may be placed. Generally, girls older than 14 years of age, and men older than 19 years of age have completed facial growth.

In some patients with long-standing edentulous spaces, there is insufficient bone buccolingually to place an implant. In these situations, two options are possible. One option involves placing the implant and allowing the threads of the implant to be exposed on the buccal. In these situations, freeze-dried decalcified bone is placed over the implant threads. Polytetrafluorethylene membrane is positioned over the bone and implant, and the flap is sutured.[11,12] The membrane is kept beneath the flap for approximately 6 to 8 weeks. It is then removed, and the soft tissue flap is replaced over the implant. Previous research using the polytetrafluorethylene membrane has shown significant bone deposition over exposed threads on implants placed in humans.

Another option for increasing the width of the alveolus is to build-up the ridge before implant placement.[13] In patients with narrow ridges, it is necessary to expose the bone, place freeze-dried decalcified or autogentous bone in the area, and cover the ridge with specially designed polytetrafluorethylene membrane. This membrane forms a tent over the ridge. It prevents epithelium from migrating into the area. The implanted bone will form a scaffolding on which the body will create a wider edentulous ridge. After this has been accomplished, the implants can then be placed in this newly formed ridge. Previous research has shown that both of these efforts at ridge augmentation are possible. If the alveolar ridge is extremely thin, then augmentation of the ridge before implant placement is usually necessary.

The implants used in the three patients in this article were 3.75 mm in diameter. However, the 3.75 mm implant has some disadvantages. It is appropriate in the premolar region, because the width of the implant is similar to the width of the cervical region of an average premolar. However, in the maxillary or mandibular anterior regions, it is often difficult to place a 3.75 mm implant between adjacent teeth. In the posterior region, a 3.75 mm implant is too narrow and adversely affects the cervical contour of the final crown. In the future, implants will be available in various sizes. The clinician will place the largest implant possible into a specific site.

When implants are used as anchors for orthodontic movement, sufficient time must elapse between placement of the implant and application of the orthodontic force. How much time is necessary? When restorations are to be placed on implants, generally a period of 4 to 6 months is recommended before uncovering the implant. What is the time interval based upon? Actually, this interval represents the amount of time required by the body to initially deposit and then remodel bone around the implant. Previous researchers have shown that this process takes about 16 to 18 months in humans.[14,15] When an implant is initially placed, nonlamellar bone is deposited adjacent to the implant.[14,15] This is weak bone. It will not withstand occlusal forces. Over time, this bone will undergo remodeling and form secondary osteons. The latter strengthens the bone. After secondary remodeling has occurred, the implant may be uncovered, and a restoration may be placed. But is this time interval sufficient for orthodontic movement? A period of 6 months had elapsed between implant placement and application of the force for the three patients reported in this article. In all cases, the implants remained immobile. In humans, it appears that 6 months is satisfactory to ensure that the implants will remain immobile during the application of orthodontic force. This guideline may not apply to implants placed in the maxillary arch, or for different types of implant materials.

When an implant is used as an abutment for orthodontic movement, a suitable provisional crown should be placed on the implant. This restoration should be contoured so that an orthodontic bracket may be attached to the crown. The size of the provisional crown may be

easily determined from the diagnostic wax set-up.[7-8] After orthodontic treatment, when should the final restoration be placed on the implant? If the implant was used as an abutment to anchor the movement of adjacent teeth, the timing of the final restoration is determined by the mobility of the adjacent teeth. The implant may be restored immediately after orthodontic treatment, unless it is attached to an adjacent mobile tooth. After orthodontics, most teeth are usually mobile and may move during the restorative process. It is much safer to wait at least 6 months until the teeth have stabilized before restoring the implant.

Summary

In this article, the combined orthodontic and restorative treatment of three patients was described. In each example, implants were used initially as anchors to move adjacent teeth and secondarily as abutments for fixed restorations. The timing, sequencing, and method of establishing the proper location of the implants were described. The need for a diagnostic wax set-up to predict implant location was emphasized. The most important factor of the entire process is interdisciplinary communication and planning. It is critically important for the orthodontist, periodontist, and restorative dentist to work closely as a team during the planning and treatment stages to achieve the best possible final result.

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