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Oral Prosthodontic Rehabilitation for Traumatic Sports Injuries

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Sports-related traumatic injuries to the oral and facial structures span all cultures and have been recorded historically ever since human beings accepted the competitive challenge. The loss of natural dentition through accident or deliberate action has been part and parcel of our competitive nature. Dental injuries have occurred in the sporting arenas pitting man against beast, man against man, man against the elements, and in modern history, man against technology. Historic gladiators and modern day matadors have not only lost teeth, but life and limb as well, in colosseum combat. From that historic arena to modern day events of high-speed auto racing, motor cross, jet skiing, and aviation aerobatics, tooth loss from time to time still accompanies the sweet taste of victory and the anguish of defeat. The greatest tooth loss scenario however comes in man's combat with man. In the twentieth century contact sports have evolved with a greater measure of safety in the 1990s then previously recognized in the early decades. Popularized American sports such as football, basketball, hockey, and boxing have produced a myriad of dental problems; the most serious of which is the loss of natural dentition. Other competitive sports often thought of as genteel and not of a contact nature have also produced inadvertent tooth loss. Racquet ball, tennis, golf, horseback riding, swimming, diving, water skiing, volley ball, and even bocci and croquet have produced a variety of unusual tooth loss situations.

Better than 90% of all tooth loss resulting from sports-related injuries occurs in the anterior part of the mouth.[12] In most instances the traumatic impact comes from either the injured player moving toward an inanimate object or an oncharging competitor. The results create a variety of hard and soft tissue changes. Facial lacerations frequently

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cover deep-seated fractures of teeth and alveolar bone. The avulsion of anterior teeth is often the simplest tooth loss trauma. Fractured roots and compound fractures of the alveolus are more complicated and create greater devastation and posttrauma prosthodontic challenges.

Perhaps centuries ago the anterior edentulous appearance of a gladiator became his badge of courage. In modern society, however, tooth loss without replacement is socially unacceptable.

PROSTHETIC DENTISTRY'S ROLE IN REPLACEMENT OF TEETH LOST IN SPORTS-RELATED ACCIDENTS

Temporary Removable Partial Dentures

The role of prosthodontics in managing the traumatic loss of teeth due to sports-related injuries is complex and expansive. Historically, the simplest form of tooth replacement has been the use of removable dental appliances. Even in modern dentistry the use of easily fabricated temporary removable appliances provide the traumatized partially edentulous patient with an immediate replacement for the lost dentition. This form of treatment offers psychological and often times physical comfort for the athlete (Fig. 1).

Traditional Fixed Partial Dentures

As prosthetic dentistry grew with technologic advancements, the use of fixed prosthodontics and a more permanent form of replacement became the treatment of choice. The loss of maxillary incisors due to a fall or a competitor's blow could be treated with nonremovable bridgework generally following a preparatory treatment program.

When fixed prosthodontics is considered for sports-related tooth loss, the patient must be examined thoroughly prior to finalizing the treatment plan. Because of impact trauma, teeth adjacent to the edentulous area also may have been affected. Thorough radiographic examination is necessary to determine the condition of potential abutment teeth and surrounding alveolar bone. Clinical examination to determine mobility factors of these same abutment teeth will help the clinician decide on the number of teeth required to support a replacement prosthesis. The condition of the pulpal tissues and the vitality of adjacent teeth may require endodontic intervention. If supporting abutment teeth have been traumatically injured or partially fractured, the replacement of missing tooth structure may be necessary following root canal therapy through the use of a post and core (Fig. 2).

Because traumatic injuries produce swelling and edema in the edentulous area, an interim restoration is recommended permitting an appropriate healing time before construction of a final prosthesis. This healing time serves well to permit the injured athlete time to accommodate both the concept of fixed prosthodontics as well as to the physical change in the dentition. Reduction of edema and healing of the edentulous alveolar ridge is necessary to establish a physiologic

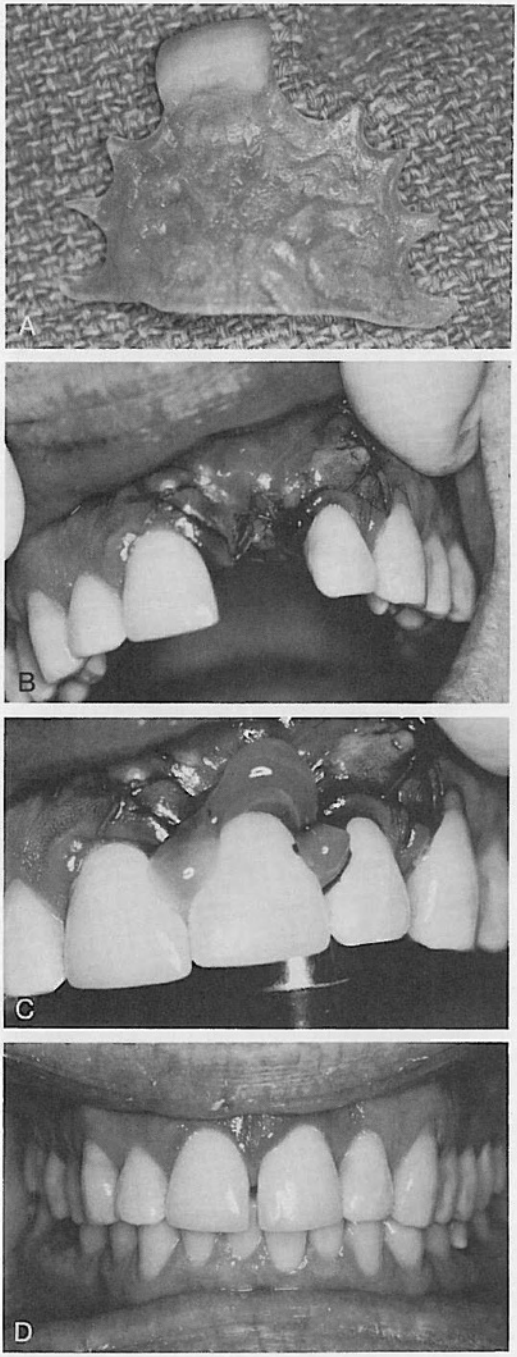

Figure 1. *A*, Temporary removable partial denture used as an immediate replacement for traumatically lost teeth. *B*, Tramatic loss of tooth No. 9. *C*, Light-cured soft reliner after root fragments are removed. *D*, Three weeks healing following root removal.

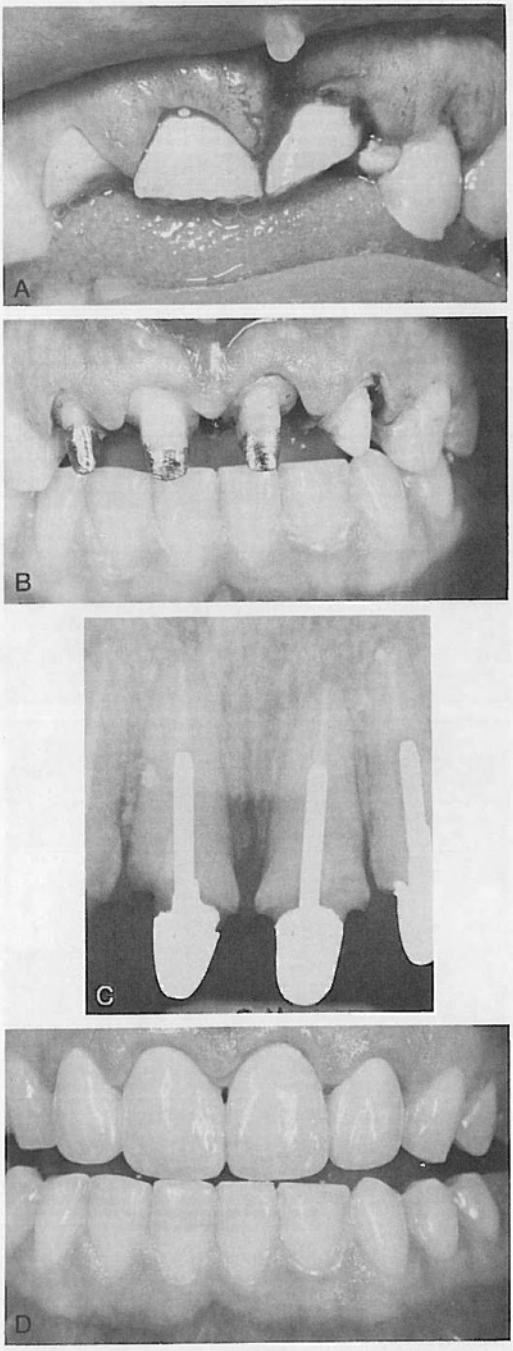

Figure 2. *A*, Fractured maxillary incisors. *B*, Cast gold post and cores cemented. *C*, Post-cementation radiograph. *D*, Final porcelain fused to gold crowns.

relationship between the fixed replacement teeth (pontics) and the remaining vital tissues (Fig. 3).

Resin-Bonded Fixed Partial Dentures

For decades full cast crowns with either acrylic or porcelain veneers were used as abutment teeth to support successfully the replacement pontics. With the advent of composite resin in the 1950s and the advances in enamel bonding during the last two decades, replacement of small numbers of teeth with resin-bonded retainers has been used in many instances as an interim form of tooth replacement and, in some cases, as a long-term form of prosthetic treatment. Resin-bonded retainers rely on the clinicians ability to isolate healthy enamel of the adjacent abutment teeth, and produce a mechano-chemical bond between the metallic lingual wings of the prosthesis to the abutment enamel (Fig. 4).

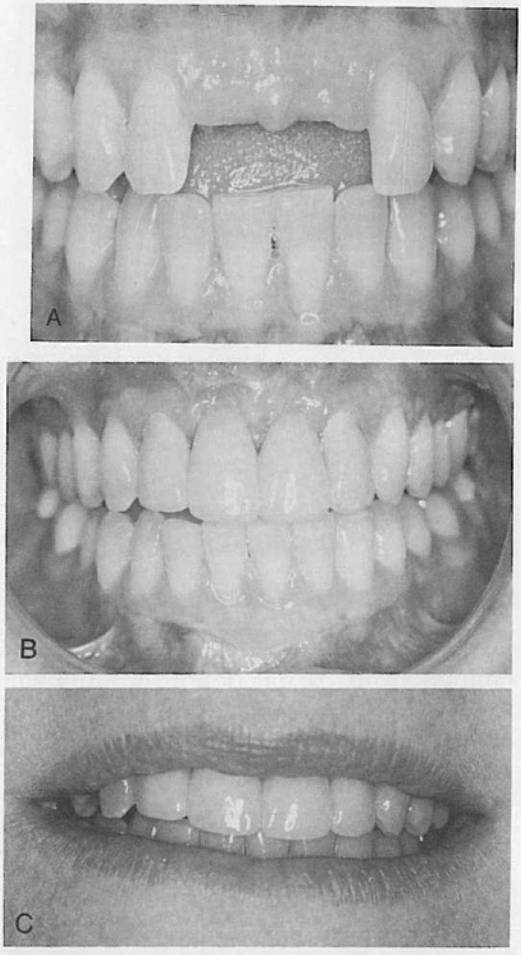

Figure 3. *A*, Preprosthodontic treatment condition following sports injury and loss of teeth Nos. 8 and 9. *B*, Porcelain fused to gold fixed partial denture. *C*, Esthetic smile line following final prosthesis delivery.

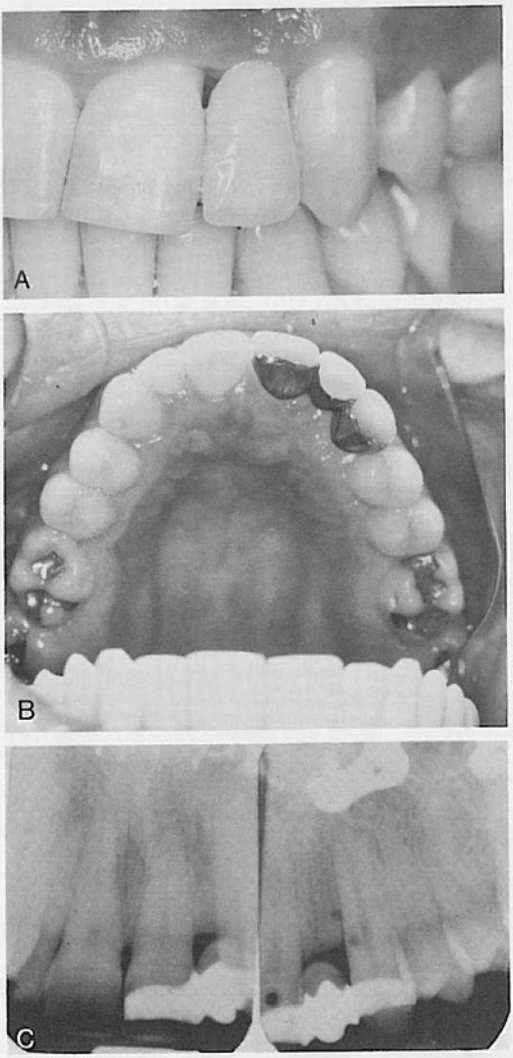

Figure 4. A, Maxillary left lateral incisor lost after roller skating accident. Porcelain fused to a base metal alloy provides an esthetic resin-bonded replacement. *B*, Lingual view of metal retaining wings bonded to the adjacent abutment teeth. *C*, Postoperative radiograph of resin-bonded fixed partial denture.

Careful patient selection is required for the effective use of resin-bonded fixed partial dentures. Adequate occlusal clearance for the lingual retentive wings should be determined by examining accurately mounted diagnostic casts. The strength and efficacy of this prosthesis is only as strong as the resin bond between the enamel and the base metal alloy.

Patients with known allergies to the contents of base metal alloys should not be considered as candidates for this prosthesis. In some cases, particularly with the female population, high instances of allergies have been reported particularly to metals that contain nickel and beryllium. In addition, patients with parafunctional habits, such as

bruxism and clenching, should be treated with a more durably retained prosthesis.

In the same area of treatment, patients who have sustained a contact injury to the natural dentition without tooth loss, frequently benefit from a resin-bonded retainer form of stabilization (Fig. 5). The 3-year postoperative radiograph in Figure 5E illustrates a condition of shortened root length following traumatic movement of teeth. Emergency stabilization was accomplished with orthodontic brackets and an arch wire placed on the labial. This permitted continued stability while lingual impressions were made to fabricate the lingual-bonded retaining splint.

The concept of using a resin-bonded fixed partial denture or resin-bonded retaining splints have many positive aspects and equally as many drawbacks. The advantages of these forms of prostheses are thought to be the conservative form of the abutment tooth preparation. History, however, has demonstrated well the frequent maintenance problems often found with inadequately designed resin-bonded fixed partial dentures and resin-bonded retaining splints, unless extensive abutment preparation has been accomplished.

All Porcelain Resin-Bonded Fixed Partial Dentures

Recently some attempts have been made to use an all porcelain-bonded restoration replacing a missing tooth. Most clinicians who have attempted this, however, agree that the strength of both the porcelain and its bond, when multiple units are joined, leads frequently to either fracture of the prosthesis or debonding of the supporting wings[10] (and Kenneth Malament, personal commmunication, 1990).

LARGE EDENTULOUS AREAS: THE USE OF REMOVABLE PARTIAL DENTURES

When extensive tooth loss has occurred, the abutment teeth are often spaced widely. The use of a fixed partial denture may be contraindicated. An excellent example of this condition is the loss of all of the maxillary anterior teeth. Under these circumstances the use of multiple posterior abutments for maximum retention of the fixed prosthesis would place these teeth under severe strain because of the forces applied to the anterior cantilever pontic section. A removable partial denture would then be indicated. It is not uncommon when large numbers of teeth are lost and the traumatic injury is severe, that portions of the alveolar ridge are also lost (Fig. 6). When this occurs the removable partial denture also provides a functional and esthetic replacement for the lost residual ridge tissue.

Following extensive loss of teeth in sports-related injuries, a temporary removable restoration is used to allow adequate ridge healing and the cessation of edema in the area. Sometimes surgical reconstruction of the alveolar ridge may be required prior to completion of the final removable prosthesis.

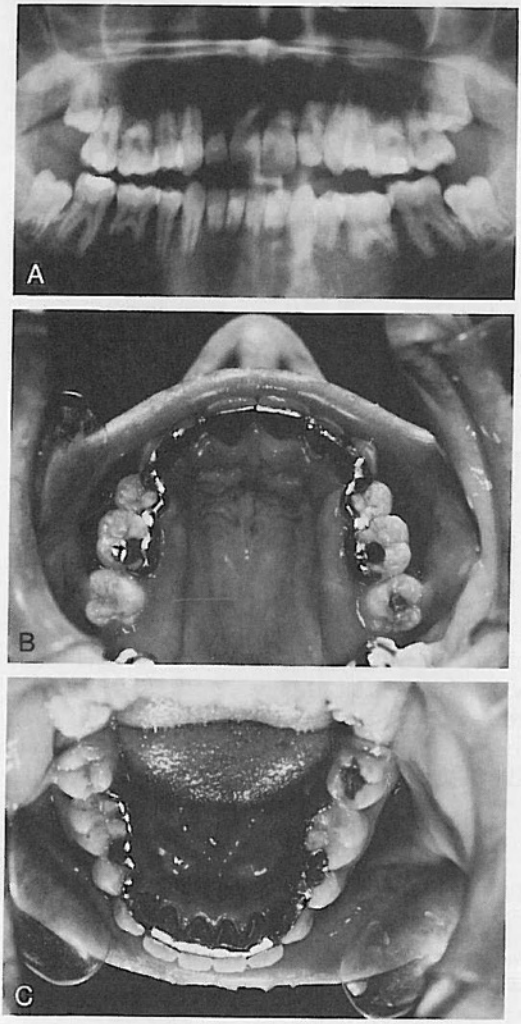

Figure 5. *A*, Traumatically loosened teeth following a horseback riding fall were initially retained with orthodontic brackets and an arch wire. The posttrauma resorption evident on the radiograph left these teeth quite mobile. *B*, Palatal view of resin-bonded maxillary splint. *C*, Lingual view of resin-bonded mandibular splint. (*Illustration continued on opposite page*)

The final design and construction of the removable partial denture should consider essential elements including: (1) careful treatment planning regarding esthetics; (2) phonetics; (3) function; and (4) stability of the prosthesis.

Removable Partial Denture Esthetics

Esthetics should reproduce the patients pre-injury condition. The use of pretreatment photographs showing the smile line and the position of the incisal edge as well as the relationship of the cervical junction to the mucosal tissues is important in establishing the most ideal esthetic result. The selection of denture teeth for this prosthesis will relate to cosmetics, function, and the opposing dentition. In the

Figure 5 (*Continued*). *D*, Anterior view with maxillary and mandibular resin-bonded splints. *E*, Postoperative radiograph shows poor crown-to-root ratio of stabilized incisor 3 years later.

past, the use of porcelain denture teeth provided excellent cosmetics; however, porcelain denture teeth produce an excessive wear on the opposing natural dentition. (Fig. 7).

More recently, the use of high-impact acrylic and composite resin denture teeth allows the clinician to provide the injured patient with an esthetic and functional restoration. If additional strength is required the lingual aspect of the partial denture casting may be brought into a functional area allowing the denture teeth to simply function as an esthetic veneer.

Removable Partial Denture Retention

Removable partial denture retention for a large prosthesis, particularly one replacing the maxillary anterior teeth, is an essential element to the long-term success of this prosthesis. If the remaining natural dentition is intact, the clinician has the choice of two philosophic and clinical concepts in denture retention.

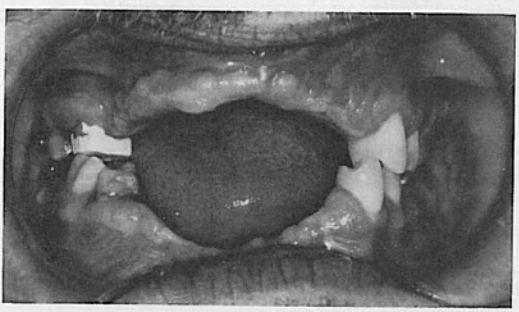

Figure 6. Severe loss of teeth and alveolar ridge following traumatic injury.

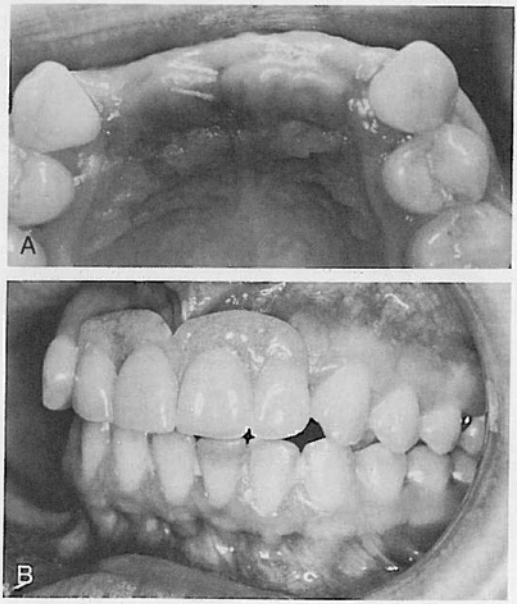

Figure 7. *A*, Traumatic water skiing accident led to loss of the maxillary incisors. *B*, A conventional removable partial denture provides an esthetic replacement for the missing anterior teeth.

Conventional Clasped. Traditional conventional clasping with retentive and bracing arms joined to a sturdy major connector is an essential ingredient in any removable partial denture.[11] To provide such a retentive and stable mechanism, enamel preparation of the abutment teeth must be performed precisely to create guide planes, retentive concavities, and occlusal, lingual, or incisal rests. Frequently this form of removable partial denture requires the placement of occlusal rests and facial clasping that are often visible when the patient speaks, laughs, or smiles (Fig. 8). The alternative to unsightly traditional partial denture clasping is the use of internal precision attachments to provide the retentive mechanism.

Precision Attachment. The internal precision attachment may take the form of a male/female groove with a lingual bracing arm. This is

Figure 8. Unsightly and esthetically detracting metal clasp on the bicuspid was required to achieve stability.

one of the most common forms of precision attachment removable partial dentures. The advantages of this form of prosthesis are both esthetic and functional. Esthetically, the elimination of facial clasping and the delicate attachment mechanism provides a very natural appearance for the placement of missing teeth. Functionally, the internal attachments in full crown restorations provide a long axis loading of the abutment teeth, a more favorable condition than traditionally clasped restorations. Another distinct advantage of both the precision attachment removable partial denture, as well as that of the conventionally clasped partial denture, is the ease of oral hygiene maintenance. The patient can cleanse the appliance extraorally and have easy access to the remaining abutment teeth for oral hygiene (Fig. 9).

Extracoronal precision attachments such as the Ceka (Preat, San Mateo, CA) and Dalbo (APM Sterngold, Mount Vernon, NY) attachments are also effective retentive mechanisms for removable partial dentures.

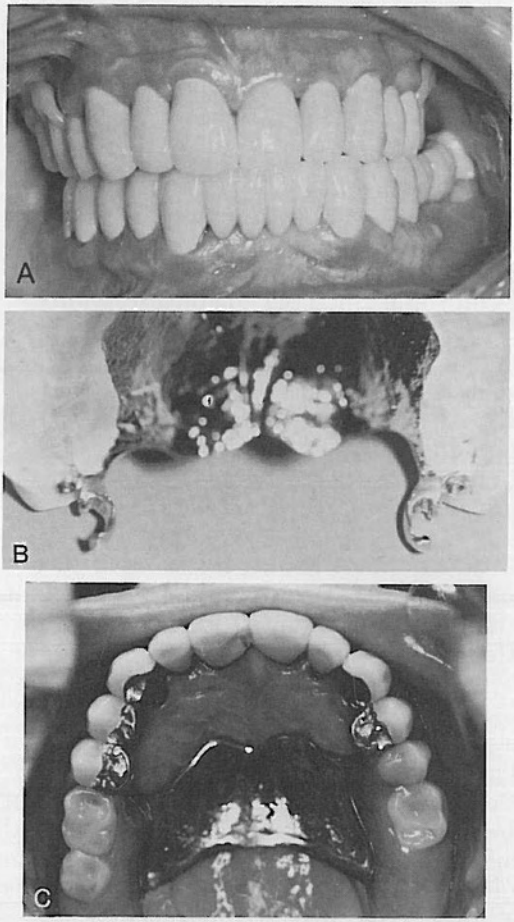

Figure 9. *A*, Abutment teeth with full crown restorations contain the retentive attachment within the esthetic and physiologic coronal contours. *B*, Intracoronal cylinder attachments have a variety of retentive adjustments in addition to the lingual bracing arms. *C*, Palatal view shows hidden attachments for precision removable partial denture.

Disadvantages of precision attachment removable partial dentures are the extensive preparation time required for the abutment teeth crowns as well as the complex and precise technology necessary to produce such a precision appliance. Long-term maintenance may also be a disadvantage when precision attachments begin to wear. Replacement of the removable partial denture itself is generally possible unless the attachment receptacle in the abutment crown wears excessively. Keeping in mind the maintenance factors and wear on the attachment components, the clinician should be completely familiar with all of the pros and cons relating to any attachment system for the precision removable partial denture and these should be discussed throughly with the patient prior to treatment.

Another disadvantage of a removable partial denture is the potential for breakage of the appliance. Even the most diligent and careful patient may drop a partial denture and fracture some of the replacement teeth or bend a clasp arm during the cleansing process.

OSSEOINTEGRATION: IMPLANT PROSTHESIS REPLACEMENT

Implant prosthodontics has been available for the replacement of missing teeth for several decades. The longest scientifically studied implant is the Branemark titanium screw, which has proven that osseointegrated fixtures provide excellent long-term favorable prognosis for fixed–bone-anchored replacement teeth.[1, 2] The use of osseointegrated implants for tooth replacement for patients who have sustained traumatic injuries takes on some very special considerations.

Traumatically Avulsed Teeth

Replacement of teeth that have been avulsed traumatically during sports injury may be accomplished successfully using osseointegrated implants with immediate implant placement following the injury. Careful assessment of the underlying alveolar ridge, however, must be made to determine that the ridge itself has not been fractured severely during this injury.

Complete stabilization of the implant fixture is essential to obtaining osseointegration. In addition, intimate contact of the implant surfaces with alveolar bone has been an essential ingredient in the success formula for osseointegration to occur. Recently, however, some studies have shown that various barrier materials used to enhance osseous generation in areas of voids encountered frequently adjacent to fixtures placed in extraction or root avulsion sockets have been successful[13] (Fig. 10). The use of Gor-tex (W.L. Gore and Associates, Flagstaff, AZ) has been reported to produce osseous generation around titanium fixtures.[9] The author[5] and others have also reported the effective use of vicryl mesh resorbable as a barrier material to inhibit the ingrowth of epithelium around titanium Branemark fixtures where osseous voids occur at the time of initial fixture placement.[7]

Figure 10. Occlusal view of fixture in socket.

Implant Placement Secondary to Alveolar Ridge Healing

Following severe traumatic loss of numerous teeth, often seen in racing accidents producing a high-speed impact, in most instances the edentulous ridge should be allowed to heal completely prior to fixture placement. This permits complete mucosal closure over the remaining alveolar bone. Careful treatment planning is essential to determine precise fixture (implant) position, long axis angulation, and distribution relative to potential loading forces created by the implant-supported prosthesis. The use of guidestents[4] are helpful during the surgical placement of fixtures in order to obtain the most ideal position for the screw-retained prosthesis.

Biologically Conservative Tooth Replacement

A Prosthodontic Philosophy. The use of osseointegrated implants today may be considered the most biologically conservative form of tooth replacement for patients who have sustained traumatic tooth loss. Injuries sustained during most sporting contacts are generally non-repetitive and permit the patient to proceed with complete prosthetic rehabilitation following a normal course of healing (Fig. 11). In light of this biologic conservatism, however, one must consider the professional athletic.

Removable Prosthesis Versus Fixed–Implant-Supported Prosthesis

In some circumstances, professional athletes who have lost some of the anterior dentition can benefit greatly from the use of osseointegrated implants and permanent tooth replacement. Such examples might be professional boxers and hockey players who have high-impact trauma to the anterior dentition. If such athletes continue in their professional careers, the clinician must consider carefully whether or not the use of a fixed–implant-supported prosthesis is advisable. Because osseointegration by definition is the intimate contact of living bone on the surface of a load carrying implant, without a soft tissue interface, there is absolutely no mobility to the implant fixture. Without a per-implant ligament, such as the periodontal membrane surrounding the natural dentition, any impact to the implant-

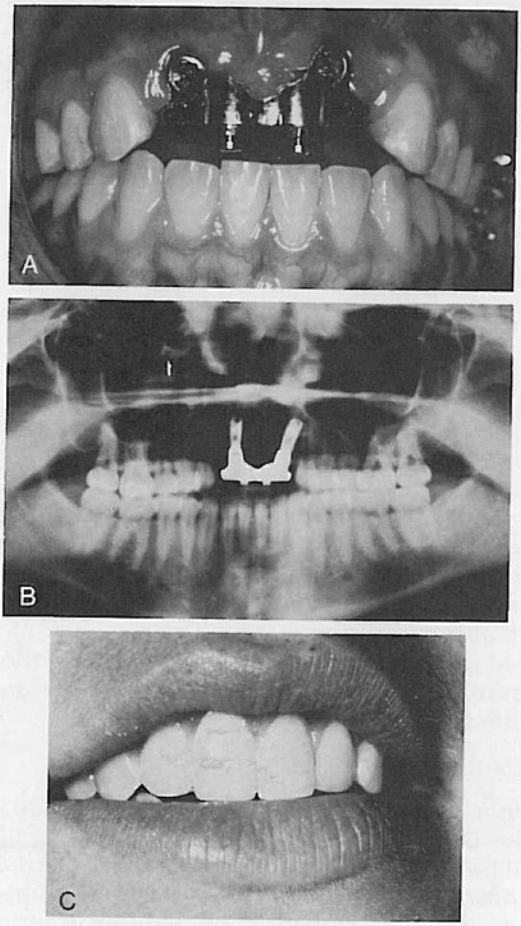

Figure 11. *A*, Incisor loss following diving accident—treated with osseointegrated Branemark fixtures. Substructure frame will support porcelain and gold prosthesis. *B*, Panoramic radiograph shows two fixtures supporting the incisor replacement. *C*, Optimal esthetic results with final prosthesis.

supported bridge will convey that same impact to the underlying bone. A sharp or sudden blow to this prosthesis may create microfractures to the bone, thereby destroying the osseointegration, leading ultimately to the failure of this bone-anchored prosthesis.

When professional athletes continue to participate actively in sports, the clinician may consider the use of osseointegrated implants to support a removable appliance with a resilient interface between the prosthetic teeth and the osseointegrated fixtures. Such appliances can be constructed in the form of overdentures with soft tissue liners.

Gold clip bars serve frequently as one of the best mechanisms for retention of the overdenture. Athletes should be advised of the nature of this implant reconstruction and forewarned that severe impact to the implant can destroy the bone/implant interface. Under these circumstances a secondary appliance should be constructed to prevent implant impact. Mouthguards and bite appliances serve well to protect

these implants. During the heat of competition, the professional hockey player, as well as the boxer, might do well to remove the implant-supported overdenture and replace it with a mouthguard to avoid implant contact fractures (Fig. 12).

For these same athletes, a fixed prosthesis may be constructed to be worn during the off season. Because of the engineering of the implant prosthesis, which uses a screw-joint–retained bridge like that seen in the Branemark system, the bar retainer for the overdenture may be removed easily at the end of the season and a fixed prosthesis secured in place with small gold fastening screws. At the end of the off season, the athlete may again switch from the fixed appliance to the removable overdenture to begin a new competitive season.

A variety of implant prostheses can be constructed to provide prosthetic replacement for both missing dentition as well as supporting alveolar and mucosal tissues. Figures 13 and 14 demonstrate several examples of various forms of tissue-integrated prostheses supported by Branemark osseointegrated implants requiring esthetic replacement of lost alveolar ridge tissue.

Temporary Teeth During Osseointegration

One form of temporization for small tooth replacement sections is the use of temporary resin-bonded retainer bridges. Wire wings on the lingual aspects of acrylic pontics can be bonded with composite resin to the lingual aspects of the adjacent teeth. The enamel of these teeth should not be prepared for additional retention because the final prosthesis will be totally independent of the natural dentition.

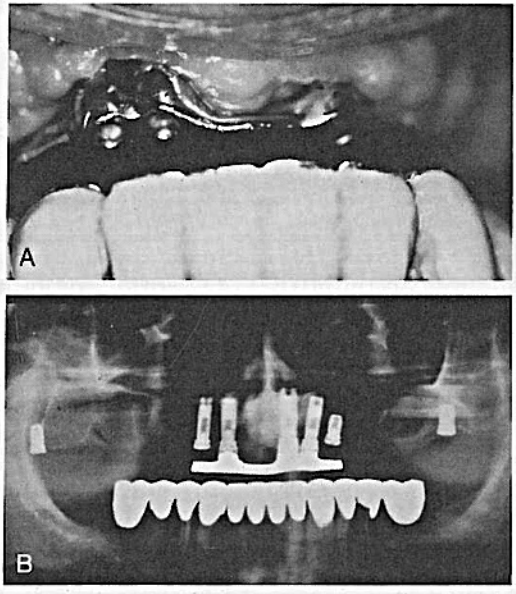

Figure 12. *A*, Type IV gold clip bar is screw-retained on osseointegrated Branemark implants. *B*, Radiograph demonstrates length of Branemark screw implants supporting the overdenture bar.

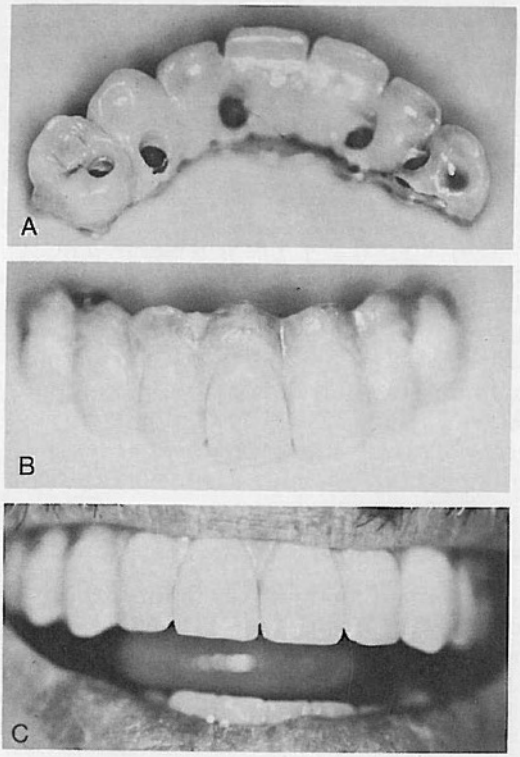

Figure 13. *A*, A five-fixture supported prosthesis replaces the anterior teeth. *B*, Traumatic loss of the alveolar ridge requires replacement of the gingival tissue in porcelain. *C*, High lip line with patient at rest shows the esthetic and functional success achieved with dental and gingival porcelain fused to a gold substructure framework.

Single Tooth Replacement

The single tooth replacement is used most frequently for traumatic injuries where tooth avulsion has occurred and the alveolar bone has remained intact. The placement of a Branemark fixture into the alveolar ridge beyond the apex of the missing tooth provides ideal anchorage for a single incisor replacement (Fig. 15). The prosthesis itself can be constructed most ideally of porcelain fused to a high-gold content substructure (Fig. 16).

Following the traumatic loss of the central incisor, fixture placement is accomplished. Osseointegration will occur 5 to 6 months following the placement of the fixture in the alveolar ridge. During this healing time the athlete will generally use a provisional removable restoration (a flipper-type appliance) for cosmetics. Function on such an appliance should be avoided.

More recently, the Branemark system has provided the Cera-One concept of single tooth replacement using a special titanium abutment fastened to the osseointegrated fixture with a gold fastening screw. This screw is designed specially to be tightened securely at 32 N/cm of torquing force using an electronic torque controller (Fig. 17).

After 5 to 6 months of osseointegration the second stage of the surgical procedure is performed to fasten securely the titanium

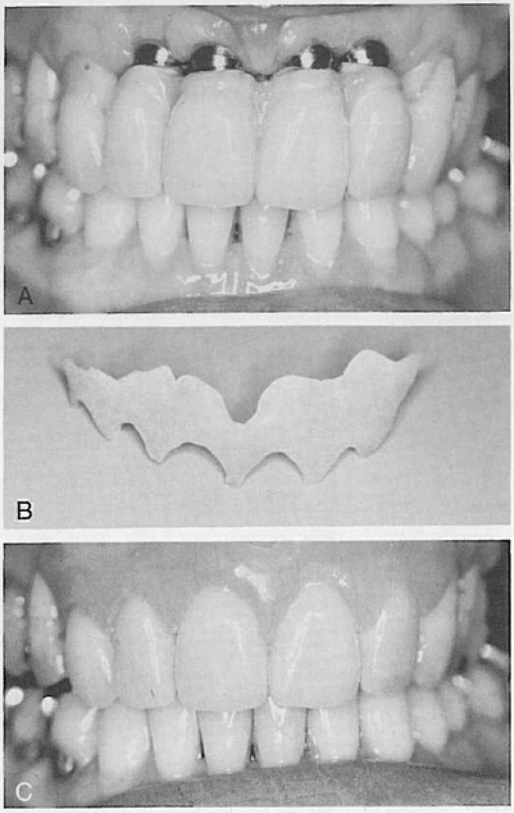

Figure 14. *A*, Nonremovable porcelain/gold tissue integrated prosthesis maintains sufficient space for oral hygiene of the titanium components. *B*, Removable gingival replacement unit. *C*, The gingival replacement unit provides the necessary esthetics for patients with a high smile line.

abutment to the osseointegrated fixture. This is accomplished using an electronic torquing device set at 32 N/cm to fuse mechanically the titanium abutment to the underlying osseointegrated implant. A prefabricated aluminum oxide ceramic core then serves as a basis for the single tooth replacement (Fig. 18). A master cast is developed by using special impression copings on the titanium abutment. A component analogue is then incorporated onto the master cast. Vita Dur N (Vita, Zahnfabrik, Germany) porcelain with crown and bridge ceramic techniques is used to develop the contours of the all-porcelain replacement. This restoration is cemented permanently to the titanium abutment.

Should retrieval of any of these components be required, the overlying crown is removed by cutting through the porcelain core and destroying the restoration. Provided the osseointegrated fixture remains intact and stable in the alveolar ridge, a new restoration can be reconstructed easily.

Multiple Tooth Replacement With Osseointegrated Fixtures

When multiple teeth have been lost traumatically, osseointegrated fixtures often provide the best and most biologically conservative form of tooth replacement. Adjacent teeth need not be treated as

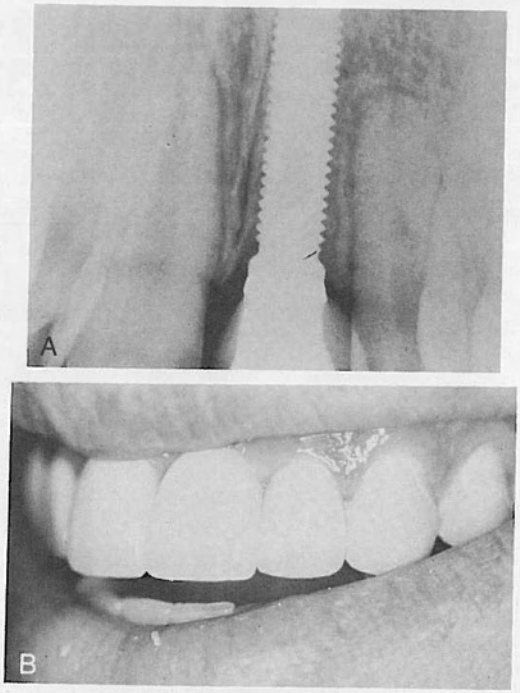

Figure 15. *A*, Radiograph of the Branemark single tooth replacement implant. *B*, Esthetic implant prosthesis replacement of maxillary left central incisor.

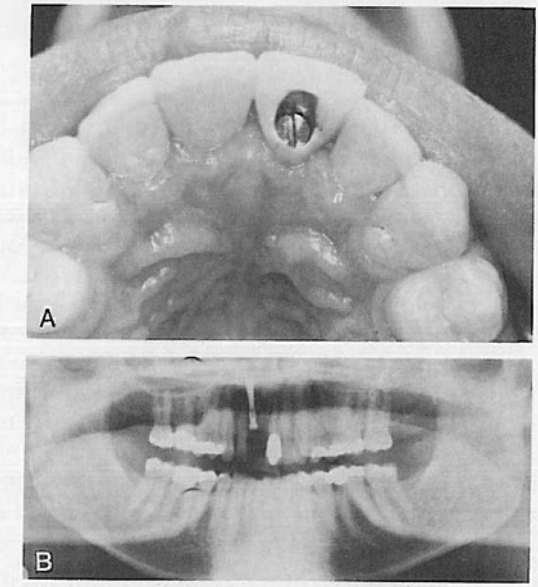

Figure 16. *A*, Racket sport injury ultimately led to loss of the central incisor. Branemark fixture is placed as lingually as possible for optimal screw access. *B*, Biking accident requiring incisor replacement. The 20-mm long fixture is stabilized in bone well beyond the tooth apex.

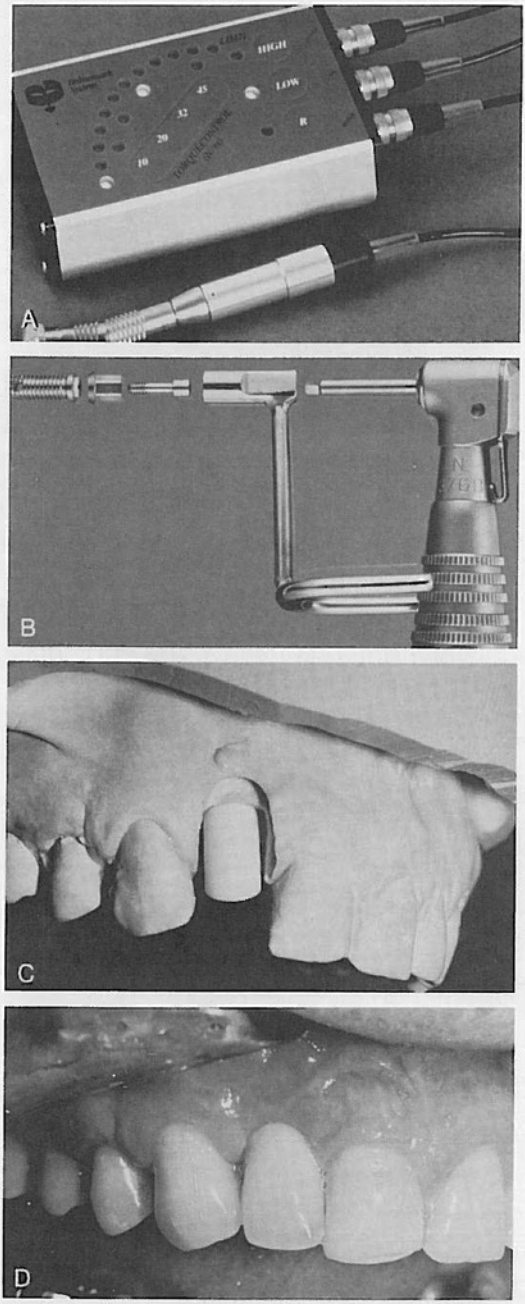

Figure 17. *A*, Electronic torque controller limits torque forces to 32 N/cm for the gold fastening screw used to hold the Cera-One abutment to the implant. *B*, Counter torque fork prevents rotational forces being transmitted to the implant. *C*, The Cera-One crown is constructed of a milled ceramic core with *D*, custom-baked porcelain veneer.

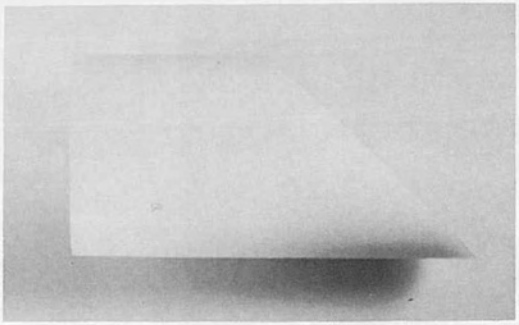

Figure 18. Aluminum oxide ceramic core.

part of this restorative prosthetic rehabilitation. Presurgical prosthodontic treatment is an essential part of the comprehensive treatment plan. This requires the fabrication of a provisional partial denture restoration to assist the clinician in determining the exact position of the replacement teeth. Information regarding the position of the incisal edges is essential to developing a stable and esthetic result with screw access holes placed on the prosthesis.

Labially Inclined Fixtures

Where the alveolar ridge has been destroyed sufficiently or normal anatomic undercuts prevent fixture placement in an ideal orientation, special prosthodontic considerations must be utilized (Fig. 19). Under

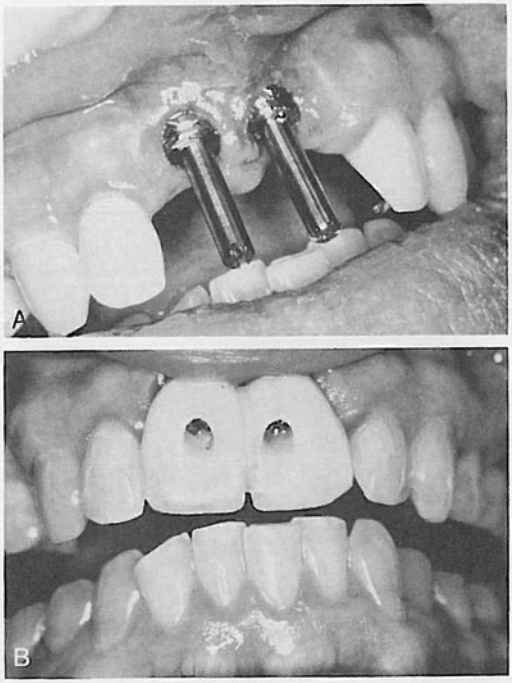

Figure 19. *A*, Labially inclined fixtures require special prosthodontic management. *B*, Implant-supported temporary prostheses show retainer screw access from the labial.

these circumstances, labial fixture inclination cannot be avoided. Long axis screw inclinations would normally produce access openings through the labial surface of the replacement teeth. This prosthetic reconstruction will require the use of either special components, such as angulated abutments, or the use of a double casting.

The first casting is generally constructed of a Class IV gold alloy fastened securely to the labially inclined fixtures. A second set of screw receptacles is placed in the horizontal strut of this "undercasting" to support an "overcasting" generally designed for a porcelain veneer. The retention of this overcasting should be accomplished with lingually oriented small set screws. If space limitations prevent the use of a second set of screws through the overcasting, mechanical retention is created through parallelism in the undercasting and the overcasting is cemented (Fig. 20).

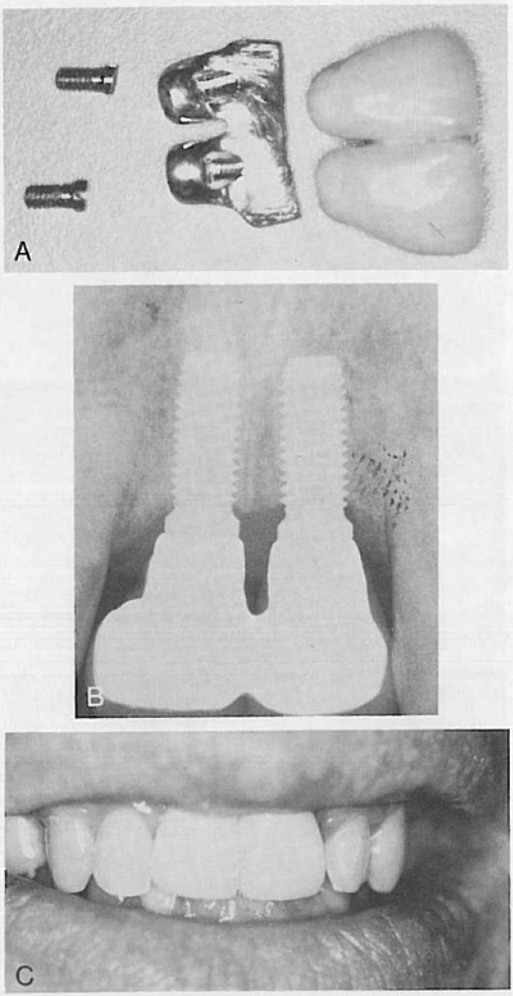

Figure 20. *A*, The "overcasting" supporting porcelain is connected to the Type IV gold substructure casting fastened to the Branemark implants. *B*, Postoperative radiograph. *C*, Porcelain and gold final restoration.

INTERDENTAL PAPILLA REPLACEMENT

Removable Gingival Unit

When large sections of the alveolar crest have been lost, the replacement of the interdental papilla for maximum esthetics is essential. The interdental papilla replacement for a tissue-integrated prosthesis can be accomplished in two forms. One form of replacement is the use of the gingival replacement unit. This small light-weight

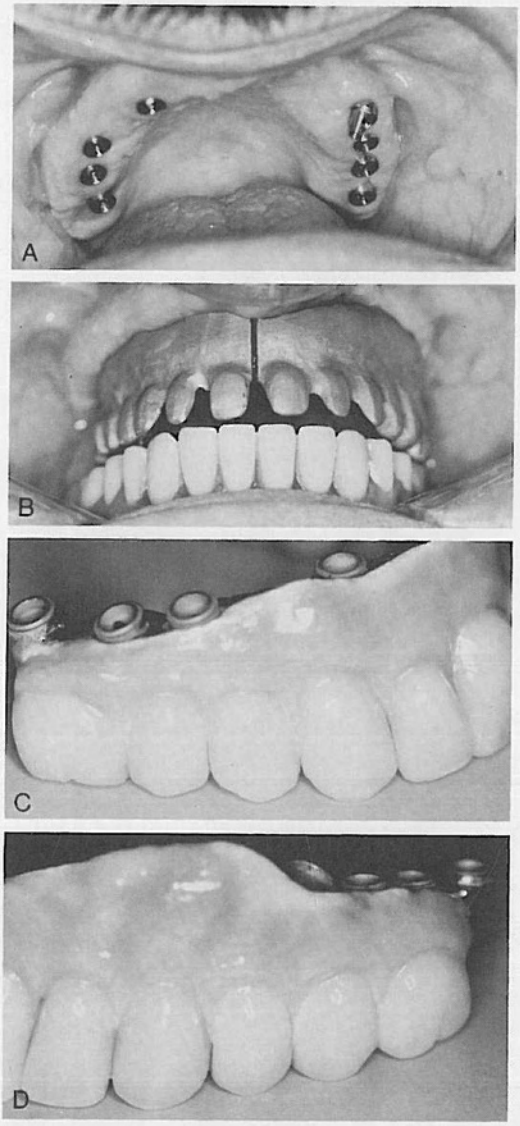

Figure 21. *A*, Traumatized maxilla with Branemark fixtures. *B*, Gold substructure designed to receive porcelain gingival veneer. *C* and *D*, Right and left lateral views. (*Illustration continued on opposite page*)

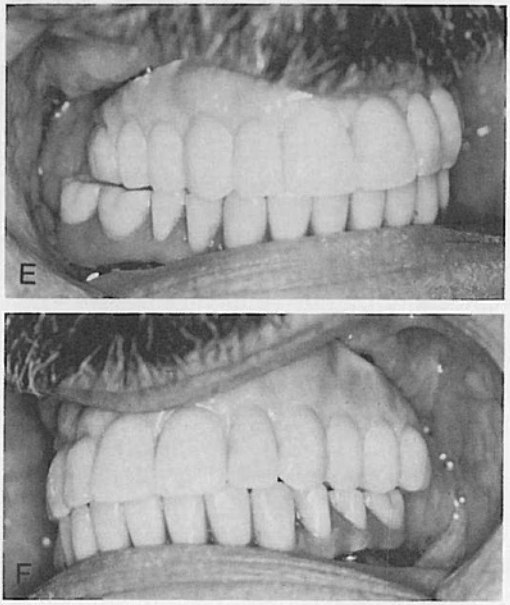

Figure 21 (*Continued*). *E* and *F*, Clinical views of porcelain gingival veneer.

acrylic or composite resin prosthesis is designed to overlay the area of loss and create a facade replacing the lost papilla. This form of removable appliance has the distinct advantage of permitting the patient to maintain easy access to the titanium abutment supporting the fixed prosthesis for maximum effective oral hygiene. The disadvantage of such a prosthesis is its very delicate nature and ease of fracture. The fabrication of several such appliances is strongly recommended to provide the patient a comfort zone when away from the dental office environment.

The gingival replacement unit can be constructed indirectly by making a labial impression of the final prosthesis fastened securely in place. The dental laboratory technician can then wax the missing mucosal tissues and interdental papilla on the master cast and process the prosthesis using an appropriately colored denture base acrylic. This hard form of gingival replacement unit is most effective in short sections. If longer sections require replacement a more flexible material should be used.

The Gingivamoll (Molloplast, Regneri, Germany) material was developed specifically for this purpose. It permits the engagement of undercuts surrounding the fixtures.[8] The disadvantage of this material is color instability and fragility.

A third alternative material for use in medium to short span sections is a light-cured composite resin material such as Triad denture reline material (Dentsply International, York, PA). The fabrication of the Triad gingival mask is probably the most esthetic form of gingival replacement and is performed directly in the mouth (see Fig. 14*A–C*).

The mucosal tissues, adjacent teeth, as well as the implant supported prosthesis are lubricated with petroleum jelly. The Triad denture base material is then warmed in hot water prior to removal from its black plastic envelope. A small section of material is applied overlaying both the labial surface of the mucosal tissues and the bridgework. Intraoral carving of the papilla is performed best with porcelain instruments. As soon as the desired shape is completed, the gingival mask is solidified with the use of a direct white light curing unit.

The patient should be instructed on the insertion and removal of these delicate appliances and on the care required for hygiene maintenance and plaque removal.[3]

Nonremovable Gingival Replacement

The alternative form of papilla and mucosal replacement is the construction of a porcelain facade as an integral part of the fixed prosthesis (Fig. 21). This is a technically difficult prosthesis to construct and requires highly skilled ceramic expertise. The advantages of a singular prosthesis with a porcelain facade are the elimination of the removable component and the frequent requirment for their duplication or replacement. Additionally, the color stability of the porcelain is superior to that of all the removable facades.

Special care must be taken in the design of the prosthesis framework to provide adequate space for oral hygiene (Fig. 22). The disadvantage of this prosthesis, in addition to the complex technical fabrication and increased laboratory costs, is the extent of the prosthesis and its close relationship to the mucosal tissues. For patients who have suffered severe tissue loss of the alveolar ridge and overlying mucosa, the prosthesis is restored more cervically than the normal cemento-enamel junction of the natural dentition. Manipulation of dental floss and other cleaning aids between the prosthesis and the mucosal tissues can be difficult and should be determined prior to the decision to build this form of prosthesis.

Biomechanical Considerations

Biomechanical considerations for the construction of a tissue-integrated prosthesis are important for patients who have sustained traumatic injuries to the alveolar bone. When alveolar bone is weakened through trauma, fracture, or because of the nature of the bone

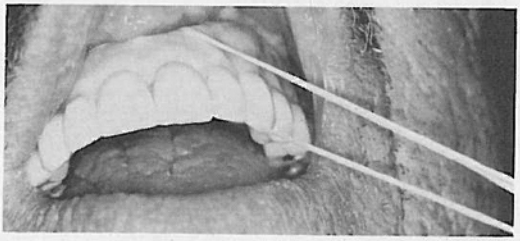

Figure 22. Sufficient space between prosthesis and mucosa permits adequate oral hygiene.

itself, then special consideration should be made for loading forces applied to the implant prosthesis.[6]

In general, several "rules of thumb" can be applied easily. Osseointegration is direct bone anchorage to titanium. If the implant receptor site has large marrow spaces with few osseous trabeculae, then only a small portion of the compact bone, that is, the trabeculae, will be in contact with the titanium. Under such circumstances multiple fixtures should be used to attempt an increased bone volume in contact with the fixtures. The more fixtures, the more bone surface will be osseointegrated in that arch.

The concept of gradual loading is a combined surgical-prosthodontic methodology. Knowledge of the bone quality and quantity is integrated in an empirical formula with the number of fixtures used to support any given prosthesis.

Should a patient present with evidence of parafunctional habits, then soft loading of newly uncovered fixtures with a soft denture liner limits the amount of force applied to these fixtures.

Gentle loading creates a remodeling stimulus to the bone surrounding the fixtures. As the remodeling increases the density and amount of cortical bone around the fixture over the loading time, other more rigid prosthesis attachment methods may be employed.

SUMMARY

Sports injuries to the mouth and oral cavity may be treated with a variety of prosthetic treatment methods. These may include a temporary removable appliance, especially when adjacent teeth are unrestored and free of caries.

Other traditional forms of prosthetic rehabilitation can range from conventional clasped removable partial dentures to traditional fixed prosthesis. The use of clip bar overdentures has demonstrated their clinical acceptability, especially for athletes involved in contact sports.

The optimal treatment for patients suffering tooth loss, however, is the use of the osseointegrated implant. This concept, developed and refined by P. I. Branemark,[1] permits successful replacement of single as well as multiple lost teeth. Criteria for patient selection must be evaluated carefully, especially for immediate fixture placement in sockets of avulsed teeth.

Professional athletes in high-impact contact sports should receive a resilient prosthesis and protective appliance to use during the sport season, followed by a screw-retained nonremovable prosthesis to be used in the off season.

Considering all forms of prosthodontic treatment available to patients with missing teeth, the use of osseointegrated implants currently appears to be the most biologically conservative approach. Retrospective studies document the effectiveness of the treatment of partially edentulous jaws, results similar or better than those reported for fully

edentulous patients indicate the effectiveness of the Branemark method of osseointegration.[2]

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