Implant dentistry is similar to all aspects of medicine in that there is one diagnosis. However, many treatment options stem from the diagnostic information. The implant treatment plan of choice at a particular moment is patient and problem centered. Not all patients should be treated with the same restoration type or design. Traditional dentistry provides limited treatment options for the edentulous patient. Because the dentist cannot add additional abutments, the restoration design is related directly to the existing oral condition. However, implant dentistry can provide a range of additional abutment locations. Bone augmentation may modify the existing edentulous conditions further in the partial and total edentulous arch and therefore also may affect the final prosthetic design. As a result, a number of treatment options are available to most partially and completely edentulous patients. Almost all creations, whether art, building, or teeth, require the end result to be visualized and precisely planned for optimal results. Blueprints that picture and list the finest details are drawn up for buildings. When asked, “How did you carve the statue of David?” Michelangelo replied, “I simply removed any piece of stone that did not represent him.” The end result should be identified clearly before the project begins. And yet implant dentists often forget this fundamental axiom. Edentulous patients come to the dentist for teeth, not implants. Historically in implant treatment, the bone available for implant insertion determined the number and locations of dental implants. The prosthesis then was determined after the position and number of implants were selected. However, to satisfy a patient's needs and desires predictably, the prosthesis should be designed first. Only after this is accomplished can one determine the abutments necessary to support the specific predetermined restoration (Fig. 4-1).

The completely edentulous patient often is treated as if cost were the primary factor in determining a plan of treatment. However, the doctor and staff should inquire specifically about the patient's desires. Some patients have a strong psychological need to have a fixed prosthesis as similar to natural teeth as possible. However, some patients do not express serious concerns whether the restoration is fixed or removable as long as specific problems are eliminated. To assess the ideal final prosthetic design, the dentist evaluates the existing anatomy after determining whether a fixed or removable restoration is desired.

An axiom of implant treatment is to provide the most predictable, most cost-effective treatment that will satisfy the patient's anatomical needs and personal desires. In the completely edentulous patient, a removable implant-supported prosthesis offers several advantages over a fixed restoration:

1. Facial esthetics can be enhanced with labial flanges and denture teeth compared with customized metal or porcelain teeth. The labial contours can replace lost bone width and height and support the labial soft tissues without hygienic compromise.
2. The prosthesis can be removed at night to manage nocturnal parafunction.
3. Fewer implants may be required.
4. The treatment may be less expensive for the patient.
5. Long-term treatment of complications is facilitated.
6. Daily home care is easier.

However, some completely edentulous patients require a fixed restoration because of desire or because their oral condition makes the fabrication of teeth difficult if a superstructure and removable prosthesis are planned. For example, when the patient has abundant bone and implants already have been placed, the lack of interarch space will not permit a removable prosthesis. Too often treatment plans for completely edentulous patients consist of a maxillary denture and a mandibular overdenture with two implants. This treatment option is often a disservice to the patient. The maxillary arch will continue to lose bone, and the bone loss may even be accelerated in the premaxilla. Once this dimension is lost, the patient will have much more problem with retention and stability of the restoration. In addition, the lack of posterior implant support in the mandible will allow posterior bone loss to continue. Paresthesia, facial changes, and reduced posterior occlusion on the maxillary prosthesis are expected. The doctor should diagnose the amount of bone loss and its consequences on facial esthetics, function, and the psychological and overall health of the patient. Hence patients should be aware of future compromises in bone loss and its associated problems with this treatment option, which does not address the continued loss of bone.

A common axiom in traditional prosthodontics for partial edentulism is to provide a fixed partial denture whenever applicable. The fewer natural teeth missing,
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the better the indication for a fixed partial denture. This axiom also applies to implant prostheses in the partially edentulous patient. Ideally, the fixed partial denture is completely implant supported rather than joining implants to teeth. This concept leads to the use of more implants in the treatment plan. Although use of more implants may be a cost disadvantage, the significant health benefits outweigh the disadvantage. The added implants in the edentulous site result in fewer pontics, more retentive units in the restoration, and less stress to the supporting bone. As a result, complications are minimized and implant and prosthesis longevity are increased. Even more important is for the dentist to visualize the final restoration at the onset with a fixed restoration. After this first important step, the dentist determines the individual areas of abutment support. If natural teeth are present in those areas, the dentist evaluates them using the criteria of traditional prosthodontics. If no natural teeth are in the areas of primary support, the dentist evaluates the bone to assess which type of implant may be placed to support the intended prosthesis. In inadequate natural or implant abutment situations, the existing oral conditions or the needs and desires of the patient must be altered. In other words, the mouth must be modified to place implants in the correct anatomical positions, or the mind of the patient must be modified to accept a different prosthesis type and its limitations.

A fixed restoration also may be indicated for the completely edentulous patient. A psychological advantage of fixed teeth is a major benefit, and patients often feel the implant teeth are “better than my own teeth.” The improvement over their removable restoration is significant. Often the completely implant-supported overdenture requires the same number of implants as a fixed restoration. Hence the cost of implant surgery may be similar for fixed or removable restorations. Fixed prostheses often last longer than overdentures because attachments do not require replacement and acrylic denture teeth wear faster than porcelain to metal. Food entrapment under a removable overdenture is often greater than for a fixed restoration because soft tissue extensions and support often are required in the latter. The laboratory fees for a fixed prosthesis may be similar to those for a bar, coping attachments, and overdenture. Because the denture or partial denture fees are much less than for fixed prostheses, many doctors charge the patient a much lower fee for removable overdentures on implants. Yet chair time and laboratory fees are often similar for fixed or removable restorations that are completely implant supported. Hence one should consider increasing the patient fees for overdentures to those more similar to fixed restorations.

A list of the advantages and disadvantages of fixed restorations follows:

Advantages
1. Psychological (feels more like natural teeth)
2. Less food entrapment
3. Less maintenance (no attachments to change or adjust)
4. Longevity (lasts the life of the implants)
5. Similar overhead cost as completely implant-supported overdentures

Figure 4-1  The dentist should select the implant type and position after determining a clear indication for a prosthesis. The final restoration, not the implant type and position, should be determined first. The patient wanted a fixed restoration in the maxilla and mandible. The surgeon only used one implant type (a mandibular staple implant). As a consequence, the patient was forced to accept the overdenture in the mandible with soft tissue support in the posterior region (a hydroxyapatite graft was used that increased the soft tissue trauma and risk of paresthesia in the mandible). The mandibular staple also was used in the maxilla, which required a LeFort (down fracture) procedure. The maxillary abutments are in the middle of the palate. The consequence of the maxillary procedure was sloughing and loss of the maxilla.
Disadvantages

1. Complications may be more difficult to treat
2. Cannot remove the prosthesis at night to decrease nocturnal parafunction
3. Lack of labial flange support in a maxillary prosthesis may affect facial esthetics
4. Hygiene may be more difficult

In 1989, Misch proposed five prosthetic options available in implant dentistry6-7 (Box 4-1). The first three options are fixed prostheses (designated FP-1 to FP-3). They may replace partial (one tooth or several) or total dentitions and may be cemented or screw-retained. They are used to convey the appearance of the final prostheses to all the implant team members. These options depend on the amount of hard and soft tissue structures replaced. Common to all fixed options is the inability of the patient to remove the prosthesis. Two types of final restorations are removable prostheses (designated RP-4 and RP-5); they depend on the amount of implant support, not the appearance of the prosthesis.

**FIXED PROSTHESES**

**FP-1**

An FP-1 is a fixed restoration and appears to the patient to replace only the anatomical crowns of the missing natural teeth. Usually loss of hard and soft tissues has been minimal. The volume and position of the residual bone often permit ideal placement of the implant in a location similar to the root of a natural tooth. The final restoration appears similar in size and contour to most traditional fixed prostheses used to restore or replace natural crowns of teeth (Fig. 4-2). The FP-1 prosthesis is desired most often in the maxillary anterior region. However, because the width or height of the crestal bone frequently is lacking, augmentation often is required before implant placement to achieve a natural-looking crown in the cervical region. Because no interdental papillae occur in edentulous ridges, soft tissue augmentation often is required after the abutment is positioned to improve the interproximal gingival contour. Ignoring this step causes open “black” triangular spaces (where papillae usually should be present) when the patient smiles. FP-1 prostheses are difficult to achieve when more than two adjacent teeth are missing. The bone loss and lack of interdental soft tissue complicate the final esthetic result, especially in the cervical region of the crowns. The final FP-1 restoration appears to the patient to be similar to a crown on a natural tooth. However, the implant abutment rarely can be treated exactly as is a natural tooth prepared for a full crown. For example, posterior mandibular implant-supported prostheses have narrower occlusal tables at the expense of the buccal contour because the implant is smaller in diameter and placed in the central fossa region of the tooth. The occlusal table usually is modified in esthetic regions to conform to the implant size and position and to direct vertical forces to the implant body.

The cervical diameter of a maxillary central incisor is about 8 mm with an oval to triangular cross section. The implant abutment is usually 4 mm in diameter and round in cross section. In addition, the placement of the implant rarely corresponds exactly to the crown-root position of the original tooth. The thin labial bone lying over the facial aspect of a maxillary anterior root remodels after tooth loss, and the crest width shifts to the palate, decreasing 40% within the first 2 years.8 Thus the implant cannot be positioned exactly as the natural tooth had been unless bone augmentation has been performed.

The restorative material of choice for an FP-1 prosthesis is porcelain to noble metal alloy. A noble metal substructure can be separated easily and soldered in case of a nonpassive fit at the metal try-in, subgingival crown margins exhibit less corrosion, and noble metals in contact with implants corrode less than nonprecious alloys. Any history of exudate around a subgingival base metal margin dramatically increases the corrosion effect between the implant and the base metal. A single-tooth FP-1 crown may use aluminum oxide cores and porcelain crowns or ceramic abutments and
porcelain crowns. However, fracture may occur with the later scenario because impact forces are greater on implants than on natural teeth.

**FP-2**

An FP-2 prosthesis appears to restore the anatomical crown and a portion of the root of the natural tooth. The volume and topography of the available bone are more apical compared with the cementoenamel junction of a natural root and dictate a different vertical implant placement compared with the FP-1 prosthesis. As a result, the incisal edge is in the correct position, but the gingival third of the crown is overextended, usually apical and lingual to the position of the original tooth. These restorations are similar to teeth exhibiting periodontal bone loss and gingival recession. The patient and the doctor should be aware from the onset of treatment that the final prosthetic teeth will appear longer than healthy natural teeth (without bone loss). If the high lip line during smiling or low lip line during speech do not display the cervical regions, the longer teeth are usually of no consequence, provided that the patient has been informed before treatment (Figs. 4-3 to 4-5).

A multiple-unit FP-2 restoration does not require as specific an implant position in the mesial or distal position because the cervical contour is not displayed during function. One may choose the implant position in relation to bone width, angulation, or hygienic considerations rather than purely esthetic demands (compared with the FP-1 prosthesis). On occasion the implant may even be placed in an embrasure between two teeth. If this occurs, the most esthetic area usually requires the incisal two thirds of the two crowns to be ideal in width, as though the implant were not present (Figs. 4-6 and 4-7). Only the cervical region is compromised. The implant should be placed in the correct facial-lingual position to ensure that hygiene and direction of forces are not compromised. The material of choice for an FP-2 prosthesis is also precious metal to porcelain. The contour of the metal work is more relevant in an FP-2 prosthesis because the amount of additional volume of tooth replacement increases the risk of unsupported porcelain in the final prosthesis.

**FP-3**

The FP-3 restoration appears to replace the natural teeth crowns and a portion of the soft tissue. As with the FP-2 prosthesis the original available bone height has decreased by natural resorption or osteoplasty at the time of implant placement. To place the incisal edge of the teeth in proper position for esthetics, function, lip support, and speech, the excessive vertical dimension to be restored requires teeth that are unnatural in length. However, unlike the FP-2 prosthesis, the patient may have a high maxillary lip line during smiling.
Prosthetic Options in Implant Dentistry

Figure 4-6  An FP-2 complete mandibular fixed prosthesis from an occlusal view. The anterior teeth appear ideal in width and contour.

Figure 4-7  The same restoration as Figure 4-6 from frontal view. Almost every implant is in the interproximal embrasure. The technician fabricated the restoration without regard to the mesiodistal position of the implant.

Figure 4-8  The high lip line during smiling shows the interdental papillary regions in the anterior maxilla. The fixed prosthesis should replace the gingival regions in the esthetic zone by soft tissue surgery or with the final restoration (FP-3).

Figure 4-9  Intraoral view of the patient in Figure 4-8. The FP-3 restoration replaces the interdental papillae with pink porcelain.

Figure 4-10  Intraoral view of an FP-3 mandibular prosthesis after 10 years. The hybrid denture tooth and pink acrylic processed to a metal substructure (as developed by Zarb) is often the restoration of choice when the crown height dimension is 15 mm or greater.

or a low mandibular lip line during speech or the patient has greater esthetic demands, and the display of longer teeth looks unnatural. In the restored gingival color of the FP-3, the teeth have a more natural appearance in size and shape and mimic the interdental papillae region. The addition of gingival-tone acrylic or porcelain for a more natural fixed prosthesis appearance often is indicated with multiple implant abutments because bone loss is common with these conditions.

Basically two approaches for an FP-3 prosthesis exist: a hybrid restoration of denture teeth, acrylic and metal substructure or a porcelain-metal restoration (Figs. 4-8 to 4-10). The primary factor that determines the restoration type is the amount of intraarch space. An excessive intraarch space means a traditional porcelain-metal restoration will have a large amount of metal in the substructure, so the porcelain thickness will not be greater than 2 mm. Otherwise, the risk of porcelain fracture increases. However, the large amount
of metal in the substructure acts as a heat sink and complicates the fabrication of the prosthesis. As the metal cools after casting, the thinner regions of metal cool first and create porosities in the structure. This may lead to fracture of the framework after loading. Furthermore, when the casting is reinserted into the oven to bake the porcelain, the heat is maintained within the casting at different rates, so the porcelain cool-down rate varies, which increases the risk of porcelain fracture. In addition, the amount of precious metal in the casting adds to the weight and cost of the restoration.

Precious metals are indicated for implant restorations to decrease the risk of corrosion and improve the accuracy of the casting because nonprecious metals shrink more during the casting process.

An alternative to the traditional porcelain-metal fixed prosthesis is a hybrid restoration. This restoration design uses a smaller metal framework, with denture teeth and acrylic to join these elements together. This restoration is less expensive to fabricate and is highly esthetic (premade denture teeth and pink soft tissue replacement). In addition, the intermediary acrylic may reduce the impact force of dynamic occlusal loads. The hybrid prosthesis is easier to repair if the porcelain fractures because the denture tooth may be replaced with less risk than adding porcelain to a traditional restoration. However, the fatigue of acrylic is greater than the traditional prosthesis, and therefore repair of the restoration is more likely.

The crown height space determination for a hybrid versus the traditional porcelain-metal restoration is 15 mm from the bone to the occlusal plane. When less space is available, the porcelain-to-metal restoration is suggested. When more intraarch space is present, a hybrid restoration is fabricated (Fig. 4-11).

An FP-3 porcelain-to-metal restoration is more difficult to fabricate for the laboratory technician than an FP-2 prosthesis. The pink porcelain is harder to make appear as soft tissue and usually requires more baking cycles. This increases the risk of porosity and porcelain fracture.

An FP-2 prosthesis rarely has interdental papillae or ideal soft tissue contours around the emergence of the crowns because these restorations are used when the cervical regions are not in the esthetic zone. The wide open embrasure may cause food impaction or speech problems when found in the maxillary arch. These complications may be solved by use of a removable soft tissue replacement device or making overcontoured cervical restorations.

Figure 4-11  An FP-1 restoration replaces an ideal-looking clinical crown. Therefore for an FP-1 restoration the bone and soft tissue volume and implant position must be ideal. The average clinical crown of an anterior tooth ranges from 9 to 12 mm in height. The ideal overjet is 2 to 4 mm. Hence the intraarch space for maxillary and mandibular FP-1 restorations usually should be 14 to 18 mm, and the bone volume at the crest should be greater than 5 mm wide.
The maxillary FP-2 or the FP-3 prosthesis often is extended or juxtaposed to the tissue so as not to impair speech. Hygiene is more difficult to achieve, although access next to each implant abutment is provided. The mandibular restoration may be left above the tissue, similar to a sanitary pontic, and this facilitates oral hygiene in the mandible, especially when the implant permucosal site is level with the floor of the mouth and the depth of the vestibule. However, if this space is too great, the lower lip may lack support in the labiomental region.

Implants placed too facial or lingual or in embrasures are easier to restore when vertical bone has been lost and an FP-2 or FP-3 prosthesis is fabricated because even extreme lip lines do not expose the implant abutments. The greater crown heights allow the correction of increased edges positions. However, because the FP-2 or FP-3 restoration has greater crown heights compared with the FP-1 fixed types of prostheses, a greater moment of force is placed on the implant cervical regions, especially during lateral forces such as mandibular excursions or with cantilevered restorations. As a result, the dentist should consider additional implant abutments or shorter cantilever lengths with these restorations.

### REMOVABLE PROSTHESSES

The two kinds of removable prostheses are based on support of the restoration (Table 4-1). Patients are able to remove the restoration but not the implant-supported superstructure attached to the abutments. The difference in the two categories of removable restorations is not in appearance as it is in the fixed categories. Instead, the two categories are determined by the amount of implant support. The most common removable implant prostheses are overdentures. Traditional removable partial dentures with clasps on implant abutment crowns have not been reported in the literature with any frequency. No long-term or short-term studies are currently available. However, complete removable overdentures often have been reported with predictability. As a result, the removable prosthetic options are primarily overdentures (Fig. 4-12).

#### RP-4

RP-4 is a removable prosthesis completely supported by the implants or teeth. The restoration is rigid when inserted; overdenture attachments usually connect the removable prosthesis to a low-profile tissue bar or superstructure that splints the implant abutments. Usually five or six implants in the mandible and six to eight implants in the maxilla are required to fabricate completely implant-supported RP-4 prostheses in patients with favorable dental criteria (Fig. 4-13).

The implant placement criteria for an RP-4 prosthesis are different from those for a fixed prosthesis. Denture teeth and bulk of acrylic are required for the removable restoration. In addition, a superstructure and overdenture attachments must be added to the implant abutments. This requires a more lingual and apical implant placement compared with the implant position for an FP-1 or FP-2 prosthesis. The implants in an RP-4 prosthesis should be placed in the mesiodistal position for the best biomechanical and hygienic situation. On occasion, the position of an attachment on the superstructure or prosthesis also may affect the amount of spacing between the implants. For example, a Hader clip requires the implant spacing to be greater than 6 mm from edge to edge and consequently reduces the number of implants that one may place between the mental foramen.

The RP-4 prosthesis may have the same appearance as an FP-1, FP-2, or FP-3 restoration. A porcelain-to-metal prosthesis with attachments in selected abutment crowns can...
be fabricated for patients with the cosmetic desire for a fixed prosthesis but with excess stresses requiring a removable restoration to reduce nocturnal bruxism.

**RP-5**

RP-5 is a removable prosthesis combining implant and soft tissue support. The amount of implant support varies. The completely edentulous mandibular overdenture may have two anterior implants independent of each other or splinted in the canine region to enhance retention, three splinted implants in the premolar and central areas to provide lateral stability, or four implants splinted with a cantilevered bar to reduce soft tissue abrasions and to limit the amount of soft tissue coverage needed for prosthesis support. The primary advantage of an RP-5 restoration is the reduced cost. The prosthesis is similar to traditional overdentures (Fig. 4-14).

The dentist may fabricate a preimplant treatment denture to ensure the patient’s satisfaction. This technique is indicated especially for patients with demanding needs and desires regarding the final esthetic result. The implant dentist also can use the treatment denture as a guide for implant placement. The patient can wear the prosthesis during the healing stage. After the implants are uncovered, the dentist fabricates the superstructure within the guidelines of the existing treatment restoration. Once this is achieved, the preimplant treatment prosthesis may be converted to the RP-4 or RP-5 restoration.

The doctor and the patient should realize that the bone will continue to resorb in the soft tissue–borne regions of the prosthesis. Relines and occlusal adjustments every few years are common maintenance requirements of an RP-5 restoration. Bone resorption with RP-5 restorations may occur 2 to 3 times faster than the resorption found with full dentures.3 This can be a factor when considering this type of treatment in young patients, despite the lower cost and low failure rate.

**SUMMARY**

In traditional dentistry the restoration reflects the existing condition of the patient. The dentist evaluates existing natural abutments first and fabricates a removable or fixed restoration accordingly. Implant dentistry is unique because additional foundation units may be created for a desired prosthetic result. Therefore the dentist should determine the psychological and anatomical needs and desires of the patient. The dentist then may design a prosthesis that satisfies these goals and eliminates the existing problems. The prosthesis may be fixed or removable for the completely edentulous patient. Most partially edentulous patients are treated using fixed restorations.

If only one implant approach is used for all patients, the same surgical and prosthetic scenarios and flaws invariably are repeated. For example, if a traditional fixed mandibular staple bone plate is used on all edentulous mandibles, not only are the implant and surgery similar regardless of intraoral or extraoral conditions, but an RP-5 prosthesis usually is the result despite the patient’s needs and desires.

The benefits of implant dentistry can be realized only when the dentist first discusses the prostheses available and determines the appropriate one for the patient. An organized treatment approach based on the prosthesis permits predictable therapy results. Five prosthetic options are available in implant dentistry. Three restorations are fixed and vary in the amount of hard and soft tissue replaced; two are removable and are based on the amount of support for the restoration (Figs. 4-15 and 4-16). The amount of support required for an implant prosthesis initially should be designed similar to traditional tooth-supported restorations. Once the dentist designs the intended prosthesis, the dentist can establish the implants and treatment for the support required.
Fixed restorations have three categories: FP-1, FP-2, and FP-3. The restoration type is related to the contour of the restoration. (FP-1 is ideal, FP-2 is hypercontoured, and FP-3 replaces the gingival drape with pink porcelain or acrylic.) The difference between FP-2 and FP-3 most often is related to the maxillary high lip position during smiling or the mandibular lip position during sibilant sounds of speech. FP-2 and FP-3 restorations often require more implant surface area support by increasing implant number or size or by adjusting design considerations.

Removable restorations have two categories based on implant support. RP-4 prostheses have complete implant support anterior and posterior. In the mandible the superstructure bar often is cantilevered from implants positioned between the foramen. The maxillary RP-4 prosthesis usually has more implants and little to no cantilever. An RP-5 restoration has primarily anterior implant support and posterior soft tissue support in the maxilla or mandible. Often fewer implants are required and bone grafting is less indicated. (From Misch CE: Contemporary implant dentistry, ed 2, St Louis, 1999, Mosby.)
References


