INTERDISCIPLINARY TREATMENT PLANNING

Principles, Design, Implementation

Michael Cohen, DDS, MSD
Editor
The incorporation of one single-tooth implant and crown, together with a series of all-ceramic crowns or veneers for the adjacent natural teeth, creates a great challenge for the clinician and dental ceramist. Endosseous implant placement requires careful staging in accordance with the healing time frames associated with tissue maturation.

[Au: Please approve the selection of this principle for the opening page or select a different one of your choice.]
Editor’s note: In this closing chapter, Dr. Starr synthesizes the treatment-planning principles relevant to a partially edentulous case. This article appeared in the Seattle Study Club Journal over a decade ago, and yet the concepts are timeless. Dr. Starr’s chapter convincingly demonstrates that once understood, the principles of treatment planning transcend the cases presented in this book and readily become part of the clinician’s everyday armamentarium.

**INTRODUCTION**

Our ultimate therapeutic goal as dentists is to achieve maximum health, masticatory function, speech, esthetics, and comfort for our patients. Generally, treatment can be divided into three levels: (1) emergency care for relief of pain or sudden dysfunction; (2) removal of the causative factors of the disease processes; and (3) removal of the effects of the disease or traumatic insult. Level 1, emergency treatment, must be accomplished before any other level of therapy is instituted (Table 17-1).

The purpose of level 2 is to control inflammation. A basic tenet of periodontal therapy is the mechanical debridement of all accretions adherent to the clinical crowns and roots of teeth or restorative materials, both supragingivally and subgingivally. This is accomplished by scaling, root planing, and curettage procedures in concert with plaque-control instruction. For dental caries, it is evident that early placement of restorations prevents the need for more extensive intervention later.

The focus of this article is level 3: attempting to correct alterations in form and function.

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<th>Treatment category</th>
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<td>Sedative restorations</td>
<td>“Direct fillings” or temporary fillings</td>
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<td>Symptomatic teeth/abscess</td>
<td>Endodontic</td>
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DIAGNOSTIC EVALUATION

Diagnosis, treatment planning, and treatment sequencing continue to be difficult and troublesome areas for dentists and dental specialists in the therapeutic approach to the partially edentulous patient. A comprehensive dental-periodontal examination must be performed first. This will ensure that all members of the treating team have addressed their problem areas and have collated their respective treatments into the overall therapeutic scheme. The clinical evaluation consists of caries, periodontal, endodontic, orthodontic, orthognathic, occlusal/temporomandibular joint (TMJ), and systemic examinations (Box 17-1). To facilitate this diagnostic evaluation, a full-mouth series of periapical radiographs of teeth and residual ridges must be taken. A panoramic radiograph, possibly a cephalometric radiograph, and a dental computed axial tomography (CAT) scan are suggested to help assess the bone quality and density and thereby supplement conventional dental radiography. CAT scan technology is often enhanced today by the use of barium-impregnated surgical templates or with gutta percha markers to more precisely analyze all available bone sites. Mounted study casts should also be made. In most situations it is suggested that two sets of original casts be taken: one to be preserved diagnostically and the other to be worked on therapeutically.

After clinical examination, radiographic imaging, and study casts, the next level of diagnosis can begin. For a case in which the needs are largely restorative, such as veneering or crowning one

<table>
<thead>
<tr>
<th>BOX 17-1</th>
<th>DIAGNOSTIC EVALUATION</th>
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<td>Caries</td>
<td>Periodontal disease</td>
</tr>
<tr>
<td>• Supragingival</td>
<td>• Degree of bone loss</td>
</tr>
<tr>
<td>• Subgingival</td>
<td>• Topography of alveolar defect (potential impact of bone loss on adjacent teeth)</td>
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<td>• Insufficient clinical crown height</td>
<td>• Classification of periodontal biotypes</td>
</tr>
<tr>
<td>Endodontic considerations</td>
<td>Size and shape of residual deformed bony ridge areas</td>
</tr>
<tr>
<td>• Symptomatic teeth</td>
<td>• The degree of resorption will influence the surgical and restorative ventures</td>
</tr>
<tr>
<td>• Separated instruments</td>
<td>Medical status</td>
</tr>
<tr>
<td>• Dystrophic calcifications</td>
<td>• Systemic disorders</td>
</tr>
<tr>
<td>• Fractured roots</td>
<td>• Psychological concerns</td>
</tr>
<tr>
<td>• Apical and lateral zones of osseous destruction</td>
<td>Traumatic injury</td>
</tr>
<tr>
<td>• Status of existing posts-cores</td>
<td>• Clinical crown deformity</td>
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<tr>
<td>Esthetics</td>
<td>• Soft and hard tissue deformities</td>
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<tr>
<td>• Smile analysis</td>
<td>• Facial deformity</td>
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<td>• Lip line analysis</td>
<td>Developmental/acquired deformities</td>
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<tr>
<td>• Gingival topography assessment</td>
<td>• Cleft palate, cleft lip</td>
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<tr>
<td>• Incisal plane assessment</td>
<td>• Anelegenesis imperfecta, other deformities</td>
</tr>
<tr>
<td>Malocclusion</td>
<td>Systemic influences</td>
</tr>
<tr>
<td>• Loss of occlusal vertical dimension</td>
<td>• Systemic diseases (eg, diabetes, cirrhosis)</td>
</tr>
<tr>
<td>Missing teeth</td>
<td>• Osteoporosis, osteopenia, osteomalacia</td>
</tr>
<tr>
<td>• Without replacement</td>
<td>• Liver or kidney dysfunction</td>
</tr>
<tr>
<td>• With delayed replacement</td>
<td>• Anticonvulsants</td>
</tr>
<tr>
<td>Occlusal trauma</td>
<td>• Antidepressants</td>
</tr>
<tr>
<td>• Primary: bruxism, clenching, retrograde wear</td>
<td>• Vitamin D deficiency</td>
</tr>
<tr>
<td>• Secondary</td>
<td>• Parathyroid hormone</td>
</tr>
<tr>
<td>• TMJ considerations</td>
<td>• Aging; estrogen deficiency</td>
</tr>
<tr>
<td>Orthodontics</td>
<td>• Gastrointestinal problems</td>
</tr>
<tr>
<td>• Tooth shift or collapse</td>
<td>• Psychiatric/psychological considerations</td>
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</table>
or more teeth, gingival esthetic guidelines may be a large component of the treatment planning. To establish a diagnosis in more compromised situations, it is important to ascertain the patient’s tooth loss history. A variety of etiologic factors may have been responsible for tooth loss: caries, subsequent endodontic complications, traumatic injuries to teeth (and/or alveolus), periodontal disease (acute or refractory), trauma from occlusion, or iatrogenes.

Many teeth may serve as strong viable abutments. However, teeth substantially affected by periodontal disease, caries, or endodontic problems must be identified early because they may have minimal value as abutments for either individual crowns or splinted restorations. These teeth may also represent a serious periodontal liability to adjacent teeth or bony ridges.

**ESTHETIC TREATMENT APPROACH**

Esthetics and osseointegration were developing on parallel paths during the mid-1980s to early 1990s. Each emphasized the importance of the integrated team approach to achieve the ultimate periodontal and restorative result. Preserving the soft tissue architecture, and in particular the papillae, was a major concern. We know that maintaining the papilla between two teeth is somewhat predictable, but between a tooth and an adjacent implant it is less predictable. Concern for the loss or reduction in height of the papilla between two adjacent implants has created a new esthetic issue. Therefore, the concepts of selective extraction of teeth and socket preservation and augmentation at the time of tooth extraction appear to be invaluable in the restoration of form, function, and esthetics.

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**Principle 1**

Esthetics plays a major role in our diagnostic and therapeutic endeavors. However, long-term clinical assessments have shown that its real value will play out optimally when it is achieved in concert with all of the functional needs of the dentition.

Tarnow and colleagues observed that in healthy mouths the gingival papilla filled the space between the teeth 100% of the time when the distance from the contact point of adjacent teeth to the crest of bone was 5 mm or less. When the distance was 6 mm, the papilla did not fill the space completely in approximately 50% of the patients, and when it was 7 mm or more, it did not fill the space in about 75% of the cases. The pronounced scalloped periodontal biotype (because of its triangular-shaped tooth) usually has a distance between 6 to 7 mm. Under normal conditions, this is the tissue type that usually has some interproximal recession with the formation of “black triangles.” Further clinical insults to the soft tissue, such as tooth preparation, excessively rapid orthodontic tooth movement, tooth extraction, scaling, root planing, and injudicious retraction of soft tissue may increase the gingival recession, thus further compromising the esthetic result (Fig 17-1). The extraction of an anterior tooth usually results in resorption of bone on the facial and interproximal surface. In addition, a decrease in the facial-lingual dimension of the interproximal areas is not uncommon. These findings are obvious in the scalloped type of periodontium and even more
obvious in the pronounced scalloped type. This can create an esthetic dilemma for both the patient and the dentist. Complicating the matter is that the root morphology of the anterior teeth is usually more tapered, both faciolingually and mesiodistally, than those found in the flat type of periodontium. The end result of extracting an anterior tooth with a scalloped type of periodontium is (1) greater loss of interproximal hard and soft tissues; (2) a more palatal positioning of the interproximal papillae; and (3) a wider mesiodistal dimension between the adjacent teeth (because of the taper of their roots). The outcome is a large noticeable black triangle, which is often treated by closing the space with a wider crown, with laminate placed on the adjacent teeth, or with the use of pink porcelain to simulate the lost gingiva. Often these options are not satisfactory.

When a patient's needs are primarily restoratively focused, such as veneering or crowning one or more teeth, gingival esthetic guidelines (Figs 17-2 and 17-3) will be a significant component of the overall effort.
To properly address the esthetic requirements of the patient, it is necessary to envision the desired outcome before performing the procedure. Esthetics is fundamentally about tooth form, and it is most predictably realized with the assistance of an intraoral diagnostic mock-up to improve incisal form, lip line esthetics, and gingival topography. (Fig 17-4) The outcome is the development of an intraoral esthetic blueprint. This results in dentist verification, improved laboratory communication, and patient affirmation. Molds of the improved intraoral anatomic form of the teeth should be poured in stone and then enhanced further in the dental laboratory with the application of wax. Silicone impressions are fabricated by the laboratory, then returned to the clinician to be used to verify proper tooth reduction.

Principle 2
The incorporation of one single-tooth implant and crown, together with a series of all-ceramic crowns or veneers for the adjacent natural teeth, creates a great challenge for the clinician and dental ceramist. Endosseous implant placement requires careful staging in accordance with the healing time frames associated with tissue maturation.

The addition of bone and soft tissue at or after tooth extraction, or of tooth lengthening by restorative and/or surgical measures to achieve esthetic outcomes, requires even greater interdisciplinary planning (Box 17-2).
## BOX 17-2 MAPPING THE COURSE OF ESTHETIC DENTAL TREATMENT WITH CERAMIC RESTORATIONS

### I. Emergency treatment
- Restore anatomic/clinical crowns
  - Fabrication of provisional acrylic restorations, or
  - Application of composite bonding to restore form

### II. Endodontic treatment
- Fractured teeth
- Pulpal involvement
- Periapical infection

### III. Initial therapy
- Debridement of plaque and calculus deposits adherent to the clinical crowns and roots of teeth or restorative materials both supra- and subgingivally
- Oral hygiene instruction

### IV. Intraoral digital imaging and diagnostic mock-up
- Enables the clinician, patient, and laboratory technician to evaluate:
  - The three-dimensional appearance, form, and function of teeth
  - The actual size, shape, and form of teeth
  - Incisal length and incisal plane relative to lip profile
  - Location and form of the gingival topography to complement tooth form relative to smile profile

### V. Anticipation of endosseous implant placement
- Placement into recently or immediately extracted tooth root(s)
- Augmentation of bone and soft tissue volume before placing the implant

### VI. Restorative tooth lengthening
- Fabrication of post-cores for teeth with insufficient tooth length/retention

### VII. Surgical tooth lengthening
- To improve the tooth’s biomechanical profile
- To enhance retention and resistance form
- To improve esthetic profile and length of tooth form

### VIII. Placement of endosseous implants
- To create an individual clinical crown
- After tissue healing associated with clinical tooth lengthening
- Use of surgical template to provide correct implant location and angulation
- At time of tooth extraction, with immediate provisional restoration (without opposing tooth contact)

### IX. Uncovering of endosseous implant(s): Two-stage protocol
- Mucogingival therapy as needed

### X. Fabrication of implant-supported provisional restoration

### XI. Tooth preparation and impression
- Performed using an index of the form of the teeth
- Use of surgical template to provide correct implant location and angulation
- Followed by a master impression technique that is predictable for the clinician

### XII. Fabrication of interim provisional restoration
- From bis-GMA or acrylic materials
- To restore tooth form, function, and esthetics on an interim basis

### XIII. Try-in/Insert of ceramic restorations
- Check the individual and collective fit of the restorations
- Adjust the contact point or contact areas
- Use radiographic verification of seating of the restorations, to help ensure successful luting, long-term function, and maintenance

### XIV. Adjustment and installation of an occlusal guard or bite platform appliance
- When deemed necessary
Dental therapeutics without implants

When sophisticated dental therapy will be managed without the use of endosseous implants, the approach to treatment can be subdivided into periodontal, orthodontic/orthognathic, occlusal, and restorative phases. These phases are interdependent even if one initially takes precedence over another, or if two or more of the phases are concurrent (Box 17-3).

**Box 17-3 Mapping the Course of Dental Therapy—Without Implants**

I. Emergency treatments (Table 17-I)

II. Scaling, root planing, curettage, oral hygiene instruction
   - Closed or open flap debridement
     A. Mechanical debridement of calculus plaque deposits adherent to clinical crowns and roots of teeth or restorative materials both supra- and subgingivally
     B. Removal of all chronic granulation tissue

III. Operative dentistry
   - Restoration and conservative control of dental caries

IV. Orthodontic treatment (partial or full)
   - Level and align teeth
   - Erupt fractured or impacted teeth
   - Extrude teeth to level infrabony defects and/or augment the bone and soft tissue topography
   - Support orthognathic correction

V. Fabrication of interim provisional restoration
   - Guidelines
     A. Replace missing and/or recently extracted teeth
     B. Maintain or improve inter- and intra-arch harmony
     C. Assess adequacy of tooth reduction
     D. Determine the clinical crown profiles
     E. Develop therapeutic occlusal scheme
     F. Control occlusal forces and assess function

VI. Periodontal surgery
   - Osseous therapy
     A. Regeneration/augmentation
       1. Regeneration of attachment apparatus of teeth
       2. Regeneration and augmentation of ridge deformities
     B. Osteotomy/osteoplasty
       1. Improve alveolar topography
       2. Achieve minimal sulcus depth
     C. Mucogingival therapy
       1. Enhance the gingival complex around teeth and implants
       2. Grafting procedures (eg, subepithelial connective tissue grafts, allogeneic dermal grafts, etc)

VII. Re-evaluation
   - Establish prognosis of the remaining teeth
     A. Function and esthetics
     B. Occlusion
     C. Phonetics
     D. Mucogingival considerations
     E. Emergence profiles

VIII. Prosthetic phase
   - Fixed prosthesis
   - Fixed-removable prostheses
   - Fabrication of an occlusal appliance after installation of the final prosthesis, when deemed necessary

IX. Maintenance
The objective of periodontal therapy is alveolar repair and restoration of normal anatomic form (gingival health). Treatment is directed at decreasing the inflammatory response by improving the osseous topography and the relationship of the overlying soft tissue, to decrease probing depth. Amsterdam\textsuperscript{20,21} has noted that this is most predictably accomplished for teeth of normal anatomic root lengths with probing depths not exceeding 4 to 7 mm [Au: Change to 7 mm, which already exceeds 4 mm?] measured from the cementoenamel junction (CEJ) (Fig 17-5). The advantage of this osseous surgical approach is an increase in the clinical crown length, and hence a final crown design with sufficient biomechanical retention-resistance.
Experimental and clinical research over the last decade has shifted the focus of periodontics toward increased use of guided tissue membrane techniques. These approaches seek to regenerate desired attachment apparatus circumscribing the periodontally compromised root. Although there is some clinical unpredictability associated with this therapeutic approach, it represents a step in the direction of augmentation/regeneration versus resection. This new era of regeneration therapeutics constitutes a positive shift in treatment strategy.

Secondary occlusal traumatism, represented by moderate-to-severe loss of alveolar support and significant clinical mobility, results in a need to splint two or more teeth to recreate collective stability and functionality. This was and continues to be predictably achieved with the use of partial- or full-coverage crowns.

Where bite collapse has occurred, the restoration is more difficult. In this case, a provisional restoration is used to replace the extracted teeth, to restore lost occlusal vertical dimension, and to establish or re-establish anterior guidance, allowing for disarticulation of posterior teeth during excursive movements (Fig 17-6).

When teeth require subgingival preparation in conjunction with full-coverage restorations, it is important to evaluate the mucogingival environment and determine the value of recreating or enhancing the masticatory mucosa. Autogenous gingival grafts, subepithelial connective tissue grafts, and repositioning of an existing gingival complex are commonly used approaches.

The orthodontic phase seeks to improve tooth alignment, erupt fractured or impacted teeth, or facilitate the extrusion of teeth with infrabony defects. If the gingival zone on the facial, lingual, or palatal surface is deficient, it is prudent to consider a mucogingival procedure before tooth movement. This minimizes the concern about recession if the tooth must assume a position not directly over its basal support.

When indicated, orthodontic intervention generally precedes the provisional restorative phase. If the protocol is reversed, the clinical team may be required to make significant additional repairs and recementations. Cement washout places teeth at greater risk of developing caries, and the patient may require a new provisional restoration before the impression phase of therapy.

After the provisional restorations are fabricated and tooth stability is achieved, the restorations can be removed to allow better access to the surgical field for correction of any residual hard and soft tissue inconsistencies. After the tissue has matured and the prognosis is established for all remaining teeth on both an individual and collective basis, subgingival preparation can be finalized and the provisional restorations relined, followed by completion of the fixed or fixed-removable prosthesis.
Fig 17-6a Pretreatment view of 55-year-old male with missing teeth (partial denture replacement), severe periodontitis, and complete bite collapse.

Fig 17-6b Posttreatment: Metal-ceramic fixed splinted restorations.

Figs 17-6c to 17-6e Pretreatment radiographic and clinical views showing periodontal and periapical pathology, a Class III malocclusion, and primary and secondary occlusal traumatism.

Figs 17-6f to 17-6h Provisional acrylic restorations (before periodontal surgical correction). Immediate replacement of extracted teeth. Lateral excursive movement demonstrating re-establishment of anterior guidance.

Figs 17-6i to 17-6k Definitive metal-ceramic fixed restorations. Prosthesis continues to function at 12 years follow-up. (Periodontal therapy by Dr M. Stiglitz, Washington, DC.)
Dental therapeutics with implants

Based on longitudinal studies of the viability\(^{24-31}\) of endosseous implantology, implants used as an integral part of periodontal prosthesis now offer the patient and dentist a more stable and predictable restoration. Their relative immobility and load-bearing capacity, when secured in a qualitatively adequate bony housing, may allow for fabrication of a fixed prosthesis resistant to displacement. The damage pattern of primary and secondary occlusal trauma attendant many teeth may be reversed. Even teeth that appear to have a hopeless prognosis may be able to assume a useful prosthetic role (Box 17-4).

In periodontal disease, as with dental caries, we may find permanent scars that complicate therapy more than the active disease process itself. In many circumstances, anatomic deformities such as an altered residual ridge form\(^ {32,33}\) or close proximity of the sinus wall\(^ {34,35}\) represent propagating factors that require additional surgical correction. These difficulties may necessitate a staged approach of augmentation, regeneration\(^ {35,36}\) or onlay grafting first,\(^ {33}\) followed by a second surgical phase of implant placement and healing.

During the past decade, implant restorations were reasonably acceptable from an esthetic perspective. However, in cases of advanced periodontal disease, the resorption of alveolar bone creates a significant challenge to achieve an aesthetic, functional restoration. Placing implants in resorbed bone often results in long, unesthetic teeth with an adverse crown-to-implant ratio. Implant positioning is critical from faciolingual, mesiodistal, and incisoapical perspectives. It was quickly determined that the type of periodontium, whether thick-flat or thin-scalloped, significantly affects the esthetic outcome. The thin-scalloped type, with its friable gingival and osseous morphology, often results in tissue recession, ultimately exposing metal at the gingival crown margins.

From a diagnostic standpoint, the dental team must try to anticipate the size and shape of the deformity that would be created by removing the involved teeth. These judgments will play heavily in the restorative design.

From a periodontal-prosthetic perspective, we know that many severely compromised teeth can still offer the patient short-term function. For this reason, the restorative dentist may strategically retain some of these teeth to facilitate an interim fixed provisional prosthesis rather than rely on a removable design.\(^ {35}\) This decreases the risk of prematurely loading the implant body, and inducing micromotion during initial stages of interfacial bony healing.\(^ {37}\) A well designed and constructed interim provisional restoration is most important now that osseointegration technology\(^ {38-46}\) and osseous regenerative technology\(^ {47,48}\) have significantly changed the timing and lengthened the timing of prosthetic treatment for the partially edentulous case (see Box 17-3). The weak remaining teeth may be removed at a later stage in favor of additional endosseous implant support, as dictated by the biomechanical needs of the final restoration.

Periodontal surgical therapy is performed for all teeth that have a favorable prognosis. Either regenerative approaches\(^ {23}\) or pocket reduction\(^ {49-51}\) and clinical crown exposure procedures should be rendered before endosseous implant placement.

When orthodontic treatment is involved, it may require early tooth positioning to create adequate space prior to implant placement. In some situations, such as a flared maxillary anterior segment with few or no posterior teeth, implants may be placed first and employed as the anchorage mechanism to retract and align the remaining teeth. In these situations, we are limited only by the treatment-planning creativity of the dental team. One must not minimize the value of orthodontic mechanotherapy to move teeth through a healthy bony environment. This can reduce and modify the size and shape of angular osseous defects, often through eruption or extrusion.\(^ {52-54}\) The improvement in hard and soft tissue topography allows the newly regenerated bone to successfully receive endosseous implants.

Forced eruption of hopeless teeth is used to alter the soft and hard tissues before placing implants. In addition, orthodontic extrusion is used to re-create lost interproximal papillae.
**BOX 17-4 MAPPING THE COURSE OF DENTAL THERAPY—WITHOUT IMPLANTS**

I. Emergency treatments (Table 17-I)

II. Scaling, root planing, curettage, oral hygiene instruction
   - Closed- or open-flap procedures
     A. Mechanical debridement of calcareous plaque deposits adherent to clinical crowns and roots of teeth or restorative materials both supra- and subgingivally
     B. Removal of all chronic granulation tissue

III. Operative dentistry
   - Conservative control of dental caries

IV. Orthodontic treatment (partial or full)
   - Level and align teeth to improve position
   - Erupt fractured or impacted teeth to rebuild/reposition bony complex
   - Exert teeth to correct infrabony defects and augment soft and hard tissue topography
   - Support orthognathic correction.

V. Fabrication of interim provisional restoration
   - Guidelines
     A. Allow for extraction of hopeless teeth
     B. Maintain or re-establish inter- and intra-arch harmony
     C. Assess adequacy of tooth reduction
     D. Determine the clinical crown profiles
     E. Develop therapeutic occlusal arrangement
     F. Control occlusal forces and assess function
     G. Allow for fabrication of “diagnostic template” with markers for radiographic analysis

VI. Periodontal surgery
   - Osseous therapy
     A. Regeneration/augmentation
       1. Regeneration of the attachment apparatus of teeth
     B. Osteotomy/osteoplasty
       1. Improve bone morphology
       2. Reduce pocket depth
   - Mucogingival therapy
     A. Enhance the gingival complex around teeth and implants
     B. Grafting procedures (eg, subepithelial connective tissue grafts, allogeneic dermal grafts, etc)

VII. Bone grafting, sinus bone augmentation procedures
   - Dictated by the need to most ideally locate and place implants

VIII. Fabrication of surgical template
   - Guide implant placement (based on clinical and radiographic interpretation)

IX. Implant placement
   - In existing alveolar bone sites or healed extraction sites
   - In bone augmentation sites (eg, sinus, alveolar ridges)
   - In fresh extraction sites

X. Interim maintenance to facilitate healing
   - For surgical sites, control the exposure of occlusive membranes and/or loose cover screws
   - For interim provisional prosthesis
     A. Repair broken acrylic joints
     B. Replace soft reline materials
   - Maintain and monitor transitional implants

XI. Transitional implant-assisted/-supported restoration
   - Preservation or augmentation of gingival complex
   - Placement of transepithelial healing components for second-stage implants
   - Allow for soft tissue maturation
   - Selection of implant abutments
   - Conversion of existing provisional to implant-assisted/-supported restoration
   - Fabrication of new implant-/implant- and tooth-assisted provisional restoration
OUTCOME-BASED PLANNING: INTERIM PROVISIONAL RESTORATIONS

The interim restoration may be designed in several different ways. One approach is to modify an existing denture or splint, reline the crowns on selected natural teeth, and convert other crowns to pontics as necessary. With a dearth of strong, well-distributed natural teeth, the existing rigid metal framework can better resist normal occlusal forces and help prevent prosthesis fracture.

The removable interim prosthesis is the least desirable measure for preserving masticatory function. Unfortunately, it must be used when the support provided by the remaining teeth is too compromised and the number and distribution of teeth is insufficient to allow for the use of a fixed prosthesis. In this situation it is imperative that the restorative dentist inspect the edentulous areas at regular clinical intervals and replace the soft liner material of the denture base when it becomes hard or brittle, or elicits a pressure ulceration in the soft tissue.

Currently, there are "temporary" or transitional dental implant systems that preclude the use of the removable appliance. They allow the clinician to use a fixed "mini-implant" or conventional endosseous implant–supported restoration throughout the phase of implant osteointegration. Ideally, a new fixed provisional restoration, with or without a rigid metal reinforcement, should be made from a diagnostic wax-up, incorporating all of the aesthetic, functional, and phonetic characteristics being considered in the case. Any pre-existing limitations should be removed. This will serve as a blueprint of the final prosthetic outcome. It can be used as a guide and will allow the dental team to plan the case construction from the desired end point in reverse order (Fig 17-7).

In advanced periodontal disease, the maxilla generally resorbs apically and palatally; therefore, the mandible appears to be much larger than the maxilla. When all of the maxillary teeth are eventually lost and the edentulous cast is mounted on an articulator, it appears as if the patient has a prognathic relationship. However, this is not a true prognathic arch profile, but rather a result of the bone resorption of the maxilla. And if the patient desires implants and a fixed restoration, this case becomes a surgical and restorative challenge. The clinician(s) must know before the implants are placed how this occlusal disparity will be corrected in the definit-
Fig 17-7a Pretreatment Class II, division 1 malocclusion with failing crown and bridgework (Au: splint?)—a result of caries, post-core failures, and periodontitis.

Fig 17-7b to 17-7d Pretreatment radiographs.

Fig 17-7e Fabrication of acrylic provisional restorations. Note the marked anterior platform created to provide both centric holding area and necessary anterior guidance. Socket preservation by Dr. Karl A. Rose [Au: Please provide city and state].

Fig 17-7f to 17-7h Radiographs of tooth preparations after fabrication of provisional restorations.

Fig 17-7i Final radiographic appearance of completed maxillary restoration.

Fig 17-7j Final ceramo-gold implant- and tooth-supported restoration.

Fig 17-7k Final radiographic appearance of completed maxillary restoration.
itive prosthesis. The volume of available bone is significant to the long-term survival of implants in this situation because of the exaggerated anterior-posterior discrepancy. It is wise and judicious to fabricate a temporary appliance simulating the final restoration before surgical procedures. This is essential when the clinician is contemplating a change in the occlusal vertical dimension. This alteration will change the faciopalatal relationships of the mandible to the maxilla.

The lip line esthetic diagnosis, as well as the lip support, will influence the decision to fabricate a fixed or removable prosthesis. A simple and effective way to make a reasonable esthetic appraisal of the final prosthesis is to evaluate the appearance of the patient's existing prosthesis. Assuming that it is acceptable to the patient and to the dentist, it is wise to duplicate the existing prosthesis and evaluate the patient's profile. If the appearance is the same as the original restoration, it can be assumed that the teeth are supporting the lip. In this situation, it is likely that an acceptable fixed restoration can be made. Conversely, if the lip "collapses in," the final prosthesis will likely require some form of labial support, often necessitating a removable prosthesis. A fixed restoration would likely be unsatisfactory.

**Principle 3**

The trends that have brought dentistry to its current level of esthetic sophistication require the clinician to predict the outcome before implants are placed. If the esthetic evaluation is inaccurate, the final result will be less than desirable to the patient and the dentist.

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**Diagnostic and Surgical Templates**

Like the surgical template, a diagnostic template with radiographic markers can be fabricated to help both surgeon and restorative dentist in analyzing available bone sites via panoramic or CT scan radiography prior to the surgical phase.

The surgical template, a guide to surgical implant placement, is fabricated from either a diagnostic wax-up or, preferably, a stone cast of the functioning provisional restoration.

After the provisional restoration is placed intraorally, impressions are taken of both the prosthesis and the underlying edentulous ridges and tooth preparations. Stone casts are made and an acrylic shell of the restoration is cured on a cast of the remaining prepared and/or unprepared teeth. Access locations and axial alignments are carefully planned with the surgeon and are carved into the acrylic form to anticipate all future implant placements.

While a lingual or palatal approach is commonly used to design the surgical guide, a facial approach may also be considered. This will provide the surgeon with an accurate visualization of the ideal implant sites, the desired path of abutment emergence, and the axis relation to the final prosthesis.

The ability to perform surgical procedures demands excellent access, which is provided by temporary removal of the provisional interim restoration. The surgeon will then orient the surgical template by securing it to the prepared and/or unprepared teeth and penetrate into the bone so as to bring about proper positioning of the implants.

Significant progress in biotechnology, radiology, and computer technology have allowed for accurate diagnosis and treatment planning. This has recently resulted in the construction of three-dimensional bone models, stereolithography (Fig 17-8), and navigational surgery to position endosseous implants with greater precision.
Figs 17-8a and 17-8d. Simulation of endosseous implant placement into four anterior maxillary sites, as determined by evidence of bone on the CT scan images.

Fig 17-8a. Premaxilla after Le Fort I osteotomy. Soft tissue graft increased ridge height by 7 mm.

Fig 17-8b. Diagnostic template using gutta percha markers and barium sulfate to locate endosseous implants in anterior maxillary region.

Fig 17-8e. Surgical template with titanium cylinders to locate the implant sites with surgical precision.

Fig 17-8f. Surgical endosseous implant placement based on CT scan technology and stereolithography.

Fig 17-8g. Provisional acrylic implant-supported transitional restoration.
**SURGICAL CONSIDERATIONS**

The well-designed treatment plan may require one of a host of scenarios to deal with the installation of endosseous implants into bony sites that either still house teeth, or have ridge deformities.

Where implant placement is anticipated, the most common approach is to extract teeth at the time of provisional restoration. Full maturation of the bony socket may then take anywhere from 3 to 6 months. The newly formed bone in these recent extraction sites has proven to be an excellent reservoir of pluripotential cells to promote successful osseointegration.

Another treatment approach may considerably shorten the duration of treatment. Here the effort is made to place the implant at the time of tooth extraction (Fig 17-9). The implant should be submerged several millimeters below the bony crest to reduce the risk of dehiscence formation. In these situations, the ability to achieve primary flap closure will decrease the risk of postoperative complications, especially if a cell-occlusive membrane is indicated.

In an effort to more precisely determine the quality of the bony housing for possible immediate implant placement and to minimize the overall maturation phase, the teeth may be sectioned horizontally at their gingival margins or at the height of the alveolus. The pulp should be extirpated, the canal medicated and sealed, and provisional restorations fabricated, leaving these tooth roots for the surgeon to extract at the time of implant placement. This approach avoids interference with early socket healing and precludes the risk of additional crestal bone resorption of the healing socket. The surgeon will decide whether to extract and immediately place an implant into the socket. In some cases, the surgeon may prefer to extract the tooth, place a bone graft and membrane, and allow the area to heal for 3 to 4 months before placing an implant.

When an edentulous ridge has a modest defect and the site has been planned for implant placement, the surgeon may elect to position the implants at an angle that corresponds to the ideal final restoration. Any possible fenestration over the implant may be corrected by placement of a physical membrane barrier (based on the principles of guided bone regeneration). Here adequate space must be achieved to promote complete reformation of the bone complex.

Dental implant placement in the atrophic or deformed alveolar ridge can be a surgical challenge. Alveolar augmentation is currently accomplished with guided bone regeneration techniques, sinus bone augmentation, bone grafting, and alveolar distraction osteogenesis. Two or more surgical interventions are frequently required to correct a major ridge deformity. First, the ridge must be reconstructed to a more normal anatomic shape and size followed by implant placement and soft tissue augmentation (Fig 17-10).
Figs 17-10a and 17-10b Views of block bone graft with fixation in the anterior maxilla. (Surgery by Dr Jeffrey Posnick [Au: Please provide city and state].)

Fig 17-10c Preparation of block graft site to place endosseous implants. First, the surgical template is installed. Measurements taken relative to the template will locate the implants vertically in the block-grafted bone relative to the cementoenamel junction of the adjacent teeth. Implants were placed to the proper mesiodistal, buccal-palatal, and vertical positions. (Surgery by Dr Garry Miller, Washington, DC.)

Fig 17-10d Soft tissue topography demonstrating modest rise and fall of gingival topography. [Au: Is edit okay?]

Fig 17-10e Definitive ceramic-gold implant- and tooth-supported restoration.

Fig 17-10f Radiographic images of definitive maxillary restoration.
Depending on the extent of the original ridge deformity, the surgical bone augmentation procedure can be relatively successful at restoring the bony contour to the following levels: Class I, 1 to 2 mm apical to the CEJ level of the adjacent teeth; Class II, 3 to 4 mm apical to the CEJ level of the adjacent teeth; Class III, 5 mm or more apical to the CEJ level of the adjacent teeth.62

In reconstructing the deformed ridge to a Class I bone level, a normal overlaying soft tissue profile will often be created. For the Class II bone level, where there is still some horizontal and vertical depression, soft tissue augmentation by means of connective tissue grafts,74,75 autogenous grafts (free or pedicle), or repositioning of the gingival complex, may mask the bony deficiency and create a normal topographic appearance.62

For the Class III level, prosthetic materials are frequently required to restore the hard tissue and soft tissue deformities and simulate the Class I reconstructed profile, which otherwise may be compromised in both height and width (Fig 17-11).62

After the bony ridge has been reconstructed and endosseous implants placed, a sufficient healing period must be observed to ensure a satisfactory “take.” Bone remodeling adjacent to implant fixtures occurs over a period of at least a year, leading to a more mature bone (lamellar compacta) within which the implant can better tolerate the forces of occlusion.77

Principle 4
The essential criteria for alveolar ridge reconstruction for successful implant placement are as follows: (1) appropriate quantity of horizontal and vertical bone and adequate quality of bone; (2) sufficient keratinized tissue overlying the bony crest; and (3) adequate distance between implants.3
TRANSITIONAL IMPLANT-ASSISTED RESTORATIONS

It is extremely important to coordinate the schedules of the surgeon and restorative dentist to begin the process of restoring the implants after an established healing period.

The surgeon will perform a small gingival punch procedure or a more extensive mucoperiosteal flap procedure, repositioning the gingival complex around the implants. A transepithelial healing component is then fastened to each implant body. After soft tissue and periosteal maturation, a high- or low-profile transepithelial abutment may be selected and a provisional restoration can be made to restore form and function (see Fig 17-4). For one-stage implants, the restorative dentist may begin the provisional restoration process directly.

When multiple implants are exposed and angulation concerns are anticipated, it is valuable to make an impression that records the orientation of the fixture heads after early soft tissue healing. A new provisional restoration may be fabricated in the laboratory (Fig 17-12) with titanium temporary cylinders that are designed to mate directly with the implant body or to a selection of available abutment heads.78
Frequently at the second stage, the existing interim provisional prosthesis must be modified by shortening the undersurface of the pontics to provide room for the healing components. Later, these components are removed; abutments of proper height are screwed into position, and temporary crown cylinders are seated, shortened to contact the opposing occlusion, and incorporated into the existing provisional restoration.

If there is any doubt as to the feasibility of accomplishing functional and esthetic alignment of the implant abutment, temporary crown cylinders can be secured directly to the implant body. It is noteworthy that these metal cylinders are available from most implant manufacturers. They ensure intimate fit to the titanium abutment or implant head and allow the clinician to start developing the anticipated contours. Of course, should the form need to be modified, the acrylic itself offers ample opportunity without jeopardizing any accuracy of fit.

A transepithelial collar of minimal height, shallow sulcular depth, and a circumscribed border of bound-down keratinized tissue are essential ingredients in allowing for conventional plaque-control measures.

Chiche et al. have pointed out that as a result of "surgical and anatomic limitations," implant placement may not correspond to the initial expectation set at the presurgical phase, and over-contouring the final restoration could create esthetic and functional liabilities. The path of emergence of the fastening screw through the prosthesis may compromise part of the facial or occlusal morphology, especially if it passes through a primary centric occlusal contact, an interproximal embrasure (or the facial veneer). Even minor discrepancies between an implant and crown axis may result in eccentric screws, since such deviations are magnified at the level of the occlusion.

The transitional prosthesis is invaluable in diagnosing these prosthetic limitations. With this early awareness, we can better anticipate and plan for the fabrication of an auxiliary substructure to facilitate the prosthetic result in the dental laboratory.

Some have conjectured that the implant-assisted provisional restoration may provide a shock-dampening effect that may be beneficial during the first year of bone maturation adjacent to the implants. Of possibly greater value is the role of the provisional restoration in establishing the esthetic, phonetic, and functional needs for the final prosthetic design.

At this stage, a radiographic and clinical evaluation of the stability of the implant fixtures is made. The weak teeth that were held strategically to support the interim prosthesis are extracted at this time. Some of the natural teeth may be removed in favor of additional implants or retained as indirect retainers in situations where fewer implants are used in the overall support of the prosthesis. If a new transitional prosthesis has recently been fabricated, there may have been a change in the occlusal vertical dimension or the esthetic form, both of which would require further modification. Additionally, it may be necessary to consider mucogingival treatment to enhance the complex of masticatory mucosa around selected teeth or implants.

**FINAL PROSTHETIC PHASE OF TREATMENT**

When the final prognosis for all teeth and implants has been established, the restorative dentist can employ crown and bridge techniques to construct the fixed or fixed-removable prosthesis. The dentist may proceed with final impressions of the natural teeth, relate them to the proper position...
of the implants or abutments, and fabricate a master mold. To initiate the laboratory procedures, the case is carefully mounted on an appropriate articulator by a series of occlusal registrations.

On the master cast, a soft tissue marginal profile should be constructed around each natural tooth die and implant analogue to simulate the gingival condition in the oral cavity. This allows for predictable abutment head selection based on height, angulation, and emergence profile.

Technical choices are now made concerning case design, case construction, the use of telescopic copings on retained natural teeth, or the use of precision dovetail slide attachments to interlock sections of teeth and implants, when indicated.

The primary substructure is fabricated and tried in, the fit of the copings is tested individually then collectively soldered, and the definitive metal-ceramic restoration is completed (Fig 17-13).

Today it is possible for the computer to be used as a complementary technique or an alternative to conventional impressions. Photogrammetry with digitized images, and laser/optical scanners can support computer-aided design/computer-assisted manufacturing (CAD/CAM) and computer-milling techniques in the fabrication of titanium-implant frameworks and ceramic and zirconium-oxide implant frameworks.

Upon delivery of the final case, a strong cement is used to secure the telescopic copings on the remaining teeth. The implant-assisted dental reconstruction is then seated with a temporary cement to create a hermetic seal at the interface of the abutment and superstructure. Retention and resistance to displacement are provided by securing the prosthesis with set screws. Using carefully machined/milled abutments, the practitioner may choose to cement the prosthesis in lieu of screw retention.
LONG-TERM PROFESSIONAL MAINTENANCE

Implant prostheses and their supporting components and adjacent tooth-supported prostheses are carefully monitored on a hygiene-recall maintenance program, alternating visitations between the surgeon and the restorative dentist. Any tissue changes or prosthetic mechanical problems can thereby be detected early and addressed accordingly. Although conventional periodontal indices such as Plaque Index, sulcus bleeding, and probing depth are not directly related to the success or failure of implant osseointegration, they may be appropriate for assessing and monitoring the health of the peri-implant tissues. Periapical and panoramic radiographs are taken at 12- to 18-month intervals to ascertain any changes that may take place in the osseous configuration around implants or natural teeth.

Mechanical failures (such as breakage of porcelain, solder joints, components, and implants) may occur long after the placement of the prosthesis, sometimes between 5 and 10 years. The clinician who deals with these types of prostheses must be committed to servicing them in the future. According to Wiskott and colleagues, fatigue failures are a “result of the development of microscopic cracks in areas of stress concentration.” Continual loadings result in the cracks fusing to an ever-growing fissure that insidiously weakens the restoration. Eventually, catastrophic failure results from a final loading cycle that exceeds the mechanical capacity of the remaining sound portion of the material. Based on the occlusal indicators, there may be great value in fitting the patient’s dentition with an occlusal appliance as part of the long-term preservation of the prosthesis.

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REFERENCES

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