The Interdisciplinary Approach to the Restoration of the Terminal Dentition Patient with an Implant–Supported Fixed Prosthesis

Richard P. Kinsel, D.D.S.  
Assistant Clinical Professor  
Department of Restorative Dentistry  
Division of Prosthodontics  
Director, Implant Dentistry Program  
Buchanan Dental Center  
University of California, San Francisco  
Private Practice  
1291 East Hillsdale Boulevard  
Foster City, California 94404  
650-573-8280 fax  
drcycle@aol.com

Daniele Capoferri, CDT  
Swiss Dental Design  
1291 East Hillsdale Boulevard  
Suite 142  
Foster City, California 94404  
650-572-9866  
swissdd@aol.com
The Interdisciplinary Approach to the Restoration of the Terminal Dentition Patient with an Implant–Supported Fixed Prosthesis

Abstract: Despite significant advances in dental therapeutics, there are patients for whom no reasonable treatment is available that will reliably restore or maintain their existing dentition. The causes for future edentulism include untreatable periodontal disease, advanced caries, failing root canal therapy, inadequate numbers of teeth to support a fixed prosthesis, or a history of failed previous rehabilitations. For these patients, dental implants supporting a fixed prosthesis provide a more predictable function and esthetics than retention of their remaining teeth.

A transitional fixed prosthesis specifically designed for a patient with terminal dentition offers the advantage of maintenance and development of proper gingival esthetics with improved function. Prior to implant placement, the gingival frame is established, enhancing the overall appearance of the final, full–arch implant rehabilitation. The specific prosthodontic, surgical, and laboratory techniques required for successful treatment of these patients are presented.

Keywords: dental implants, ovate pontics, immediately–loaded implants, gingival morphology, implant–supported dental prosthesis, transitional prostheses, interdisciplinary treatment, Sinfony™
Introduction

Although there have been significant advances in periodontics and prosthodontics, some patients have severely debilitated dentitions that cannot be successfully rehabilitated. Previously, conventional removable dentures were the only available treatment. With the success of osseointegrated dental implants, an alternative exists for predictable restoration with a fixed prosthesis. However, the patient’s expectation that their implant–supported restorations precisely duplicate the appearance of natural dentition continues to challenge the implant treatment team. Today, success can no longer be judged by whether or not the implant simply osseointegrates. Although the skilled dental technician may be able to create a restoration that emulates a natural tooth in every respect, this result may be an esthetic failure if optimal gingival profile and underlying supporting osseous structures are absent.

The patient with a terminal dentition offers a unique opportunity to maintain or further improve gingival profiles prior to implant placement. An integral part of proposed treatment includes the concept of immediately loaded implants, which appears to be successful as reported by several clinicians. 1–7

Following tooth extraction, the facial bone and the interproximal osseous alveolar crest that supports the papillae will resorb. Retention of sufficient teeth to support a transitional fixed prosthesis with ovate pontics can be used to maintain, enhance, or transform the existing gingival contours. Once the gingival frame has been successfully established, a surgical technique that eliminates the conventional full thickness reflected flap is used to place the implants. Next, the remaining abutment teeth can be removed and the provisional prosthesis converted to one that is solely implant supported.

The use of ovate pontics to support facial and interproximal tissues thus resulting in a more natural appearance is not a new concept. Many clinicians8–13 have reported on this prosthetic technique to enhance desired gingival contours of the edentulous ridge. Spear12 described the concept and protocol for maintaining papillary height and form following anterior tooth removal. The consensus of these reports validates the opinion that optimal esthetics using ovate pontics can be achieved without a deleterious effect upon the surrounding hard and soft tissues.

Restoration of the terminal dentition patient requires interdisciplinary collaboration among the prosthodontist, laboratory technician, and implant surgeon during all phases of patient care. In
addition to the normal information gathering, diagnostic casts mounted with facebow, interocclusal records, and analysis of digital photographs of the teeth relative to certain esthetic parameters must be reviewed prior to initiating treatment.

Collaborative Esthetic Evaluation and Treatment Planning

The patient chosen to demonstrate this technique was a 56–year–old female in general good health with advanced periodontal disease of the maxillary arch (Figs. 1a to 1f). Initial evaluation demonstrated a retrognathic mandibular deficiency; a missing left lateral incisor, a midline discrepancy, and the super–eruption with left inclination of the maxillary anterior teeth, an uneven occlusal plane, and a deep bite. The remaining maxillary dentition was determined by the patient’s periodontist to be either hopeless or severely compromised if conventional osseous resection therapy were instituted. Therefore, the most predictable treatment option for achieving the patient’s goals was maxillary dental implants placed to support a fixed prosthesis.

It is important to note that the esthetic parameters regarding the gingival contours and maxillary midline (Fig. 1a) were favorable for the anticipated definitive prosthesis. The facial gingiva adjacent to the canines and right central incisor was in proper horizontal position and the midline coincided with the desired position of the interdental papilla (Fig. 1f). The major esthetic deficiency was the improper present positions of the gingival contours to the desired definitive prosthetic teeth. The diagnostic casts were mounted with the facebow parallel to the horizon while the patient’s head was perpendicular and with the centric relation position interarch record (Fig. 2a and 2b). The occlusal view of the maxillary cast (Fig. 3a) clearly shows the midline discrepancy, missing left lateral incisor tooth, and constricted arch form.

The diagnostic wax–up is crucial for proper arrangement of teeth in the vertical, horizontal, and sagittal planes. From this information, the correction of the midline, occlusal, esthetic, and arch form problems were addressed by removing the first premolars. The increase in spacing allowed the technician to place the canine and incisor teeth into a more pleasing position (Figs. 3b to 3d). The facial portion of the cast has also been contoured to simulate the typical root prominence surrounding natural teeth (Fig. 3c). The excessive vertical display of the maxillary anterior teeth, uneven occlusal plane, and deep bite have also been corrected (Fig. 3d).
A properly designed provisional fixed prosthesis has a profound influence on the gingival facial and interproximal contours prior to implant placement. The transitional restoration with ovate pontics can be placed immediately following tooth extraction, thereby modifying the soft tissue surrounding the extraction sockets. Initial treatment planning required determination of those extraction sites that are most favorable for dental implants. Relevant considerations included optimal biomechanical stability of the prosthesis, bone quantity, and anatomic restrictions. Finally, the minimal numbers of abutment teeth required to support an interim acrylic resin fixed provisional prosthesis, during the typical four months of healing following tooth removal, were chosen. Often, the interim prosthesis is far more effective in developing optimal soft tissue contours without requiring additional gingival surgery by the periodontist. Unfortunately, the implant team frequently overlooks the importance of the provisional restoration.

**Fabrication of the Provisional Fixed Prosthesis**

To fabricate the interim fixed restoration, the maxillary wax–up cast was duplicated using a laboratory polysiloxane (Lab–Putty, ColtÈne, Mahwah, New Jersey, USA) impression material (Fig. 4a and 4b). This impression also serves as a matrix for the acrylic resin core of the provisional restoration. The teeth scheduled for initial extraction are removed from the stone duplicate of the wax–up cast and sockets made to extend at least 3 mm apical from the gingival margin (Fig. 4c to 4f). This will form the shape of the gingival portion of the ovate pontics and ultimately the soft tissue profile. The interim abutment teeth, which in this case included the second premolars, were reduced approximately 2 mm on the cast (Fig. 4d to 4e).

The casts of the prepared teeth were lubricated with a separating medium. A self–curing acrylic resin (SR Ivocron, Ivoclar AG, Schaan, Liechtenstein) was placed into the matrix and seated on the cast. The acrylic resin was cured in warm water under 20 psi. The acrylic core was reduced on the facial and incisal surfaces approximately 1 to 1.5 mm to allow sufficient room for the composite resin veneering material. The acrylic was treated with Rocatec (ESPE America, Inc, Norristown, PA) to improve bonding14–16 and then this is veneered with Sinfony™ (ESPE America, Inc, Norristown, PA); a light–cured composite resin. The composite resin gives the dental technician precise control of the
color, translucency, and surface characterization (Figs. 5a to 5c). Metal wire reinforcement of the provisional fixed prosthesis minimized flexure and possible fracture.

**Prosthodontic Gingival Tissue Enhancement**

The second premolars were prepared in the mouth prior to tooth removal. Following the extractions of the selected teeth, the provisional fixed prosthesis was relined with self-curing acrylic resin and cemented with a temporary luting agent. Note the clinical appearance immediately following cementation of the provisional restoration (Fig. 6a). The extraction sockets of the former canines and right central incisor are indicated by the yellow arrows. Although these extraction sites did not coincide with the desired locations of the definitive prosthetic teeth, the pontics formed interdental papillae and favorable facial gingival contours (Fig. 6b to 6d).

Following four months of healing, the implants were placed using a tissue-punch surgical technique\textsuperscript{17} that does not require the reflection of a full thickness flap or sutures (Fig. 7a and 7b). Precise location of the implant within the confines of the crown abutment is crucial. A surgical guide facilitated correct placement of each implant. The guide was fabricated by duplication of the existing provisional prosthesis in clear acrylic resin. Parallel holes of 2.5 mm in diameter were placed into the guide at the center of the prospective implant sites. Engaging the abutment teeth ensured stability of the surgical guide.

Once the implants were placed, the remaining teeth were extracted and the solid 4.0 mm abutments were connected to the implants and tightened (Fig. 7c). The standard technique of the ITI\textsuperscript{TM} implant system for impression and transfer of the implant abutment position was utilized to reline the existing interim prosthesis (Fig. 7d). The cast containing the laboratory analogs was mounted using facebow and centric relation records. The vertical dimension of occlusion was recorded using a gingival margin reference on the cast of the provisional bridge and this measurement transferred to the same position on the implant analog cast. (Fig. 7e). The provisional prosthesis was modified to incorporate the implant abutments into the former pontics and the remaining teeth on the cast were extracted and converted into ovate pontics. Special attention was given to the development of a definite cementoenamel junction and root form analogous to natural dentition to enhance the facial and proximal gingival profiles. The provisional restoration was
cemented onto the solid abutments with GC Fuji Plus (GC Corporation, Tokyo, Japan) and the excess cement thoroughly removed (Fig 7i). The advantages of an extraoral laboratory reline are simplification of the procedure, gingival margin integrity, and the curing of the acrylic resin under pressure to reduce voids and improve density. The immediate restoration of the implants is necessary for continued support of the soft tissue profile during the osseointegration period.

Following successful osseointegration of the maxillary arch implants, the provisional was removed and the solid abutments were tightened to the recommended torque of 35 Ncm. The impressions for casts, facebow transfer, and centric relation records were made. A cast of the provisional prosthesis in place served as a template for the framework design and porcelain application. The appearance of the soft tissue profile, following seating of the final porcelain fused to metal fixed prosthesis, mirrored the facial and interproximal contours typically found surrounding healthy, natural dentition (Fig 7a–e).

**Fabrication of the Definitive Restorations**

Typically, the one-piece framework can be invested and cast without requiring separation and soldering (Fig. 8a and 8b). To accurately transfer the precise positions of the implants, a die stone with minimal expansion (ResinRock, Whip Mix Corp, Louisville, Kentucky, USA) was used to fabricate the master cast. The framework wax-up was invested (GC Fujivest SuperÆ, GC Europe NV, Leuven, Belgium) and cast in precious alloy (JP–1, Jensen Industries Incorporated, North Haven, CT, USA). The definitive restorations consisted of an upper one-piece ceramometal fixed bridge (Creation™ Klema Meiningen, Austria) supported by implants at the sites of the central incisors, canines and first molars. The lower arch was restored with three implant supported porcelain crowns for the first molars and left second bicuspid, and one porcelain crown for the right second bicuspid tooth (Figs. 9a to 9d). The mandibular retrognathism prevented the establishment of anterior contacts in centric relation position; therefore the occlusion developed was group function with broad contacts in all excursive movements. After final delivery of the restorations, a mandibular occlusal guard was fabricated and worn every night to prevent the risk of coronal movement of the lower anterior segment caused by the long–term absence of contact with the palatal surfaces of the maxillary incisor teeth.
A soft tissue cast was fabricated to transfer the contour of the soft tissues for proper porcelain application (Gengisil, Techim Group, Milano, Italy). Special attention was directed toward the contours of the cementoenamel junction and gingival embrasures of the definitive prosthesis (Fig. 10a to 10c). The gingival embrasure dimensions must be biologically acceptable; however, the volume and distance from the contact point to the interseptal bone must also facilitate the maintenance of interdental papillae. Appropriately designed provisional restorations are well tolerated by the surrounding soft tissue structures leading to clinically healthy gingiva found adjacent to natural dentition (Figs. 11a to 11c). An optimal gingival contour, both facially and proximally, enhances the illusion of nature (Figs 12a to 12e). The most talented ceramist cannot compensate for missing bone or soft tissues that arise from poor treatment planning and improper sequencing of therapy.

The stability of the height of the underlying bone is also important, because the osseous crest serves as the supporting scaffold for the overlying soft tissue. Therefore, the correct positioning of the implant and the restorative platform is necessary to maintain the bone contour over time. The radiographs show the margin integrity and location of the crown–implant interface to the bone (Fig. 13). At least 2 mm of distance, coronal to the bone, is required to prevent alveolar bone loss. The significant esthetic changes in this case are evident when the outline of the definitive restorations are superimposed over the pretreatment dentition (Fig 14a and 14b).

Acknowledgment

The authors are pleased to acknowledge the considerable surgical skills of Robert E. Lamb, DDS, MSD in the placement of the dental implants.
References:


Legends to Figures 1–14:

**Figs. 1a to 1f:** A 56–year–old female presented in general good health with advanced periodontal disease of the maxillary arch. The existing problems included a retrognathic mandibular occlusion, a missing left lateral incisor, a midline discrepancy, the super–eruption with left inclination of the maxillary anterior teeth, an uneven occlusal plane, and a deep bite. Conventional periodontal therapy did not offer a predictable long–term prognosis. Note that the gingival display of the canines and right central incisor is favorable (a). The midline coincides with the desired position of the interdental papilla (f).

**Figs. 2a and 2b:** The diagnostic casts were mounted on the articulator using the facebow, which is positioned parallel to the horizon when the patient’s head is perpendicular, and the centric relation interarch record.

**Figs. 3a to 3d:** Comparison of the diagnostic cast and the wax–up using reference markers (dotted lines). Removal of the first premolars provided adequate space to improve arch form and to replace the missing left lateral incisor tooth (b). The second premolars served as interim abutments for the provisional fixed bridge. The placement of the facial gingival contours was based upon the proper tooth height once the incisal position had been determined (c). The midline, the lateral and sagittal inclinations, the excessive vertical display, the uneven occlusal plane, and the deep bite have been corrected (d)
Figs. 4a to 4f: The diagnostic wax–up was duplicated in die stone (a,b) with a polyvinylsiloxane laboratory putty impression. The first molars and anterior teeth were removed and sockets deepened at least 3 mm apical from the gingival margin (c). During the processing of the provisional prosthesis, the ovate pontics will conform to this depression, which will support and shape the facial and proximal gingiva. The second premolars were reduced approximately 2 mm on the cast and served as the interim abutments (d–f).

Figs. 5a to 5c: The acrylic core of the provisional fixed restoration has been veneered with Sinfony™ composite resin. The gingival aspects of the pontics simulate the proximal dimension of the analogous root and have narrow gingival embrasures that facilitate the formation of interdental papillae.

Figs. 6a to 6d: The teeth have been extracted with the exception of the second premolars. The provisional fixed prosthesis was relined with self–curing acrylic resin and cemented with a temporary luting agent. The extraction sockets of the former canines and right central incisor are indicated by the yellow arrows (a). After approximately three months, the provisional fixed bridge has shaped the tissue (b to d).

Figs. 7a to 7i: Four months after the teeth have been extracted, the implants were placed using a tissue–punch surgical technique into the locations of the first molars, canine, and central incisor teeth. The surgical guide engages the abutment teeth prior to extraction and facilitates correct implant placement (a,b). Once the implants have been placed, the solid 4.0 mm abutments were inserted into the implants and tightened (c). The standard technique of the ITI™ implant system for impression and transfer of the implant solid abutment position is utilized to reline the existing interim prosthesis (d). The technician adjusts the laboratory analogs to correct any angulation problem (e). The facial matrix, previously taken of the provisional bridge in situ, is used to properly index the provisional bridge on the implant analog cast. A lingual metal reinforcement is needed to ensure rigidity of the provisional bridge and reduce the risk of fracture (g). The reline is completed using a self–curing acrylic resin under 20 psi (h). The restoration is cemented onto the implant abutments with a glass ionomer luting agent (i).
Figs 8a to 8b: A dimensionally stable die stone with minimal expansion is used to fabricate the cast with the implant analogs. This allows the technician to cast the metal framework in one piece without need to separate the connectors and solder.

Figs 9a to 9d: The definitive restorations consisted of a one–piece porcelain fused to metal maxillary fixed bridge. The lower arch was restored with a combination of single porcelain fused to metal crowns supported by the lower ITI implants and the right second premolar tooth.

Figs 10a to 10c: A resilient soft tissue mask, recorded from the master cast prior to die trimming, is imperative for developing proper gingival emergence profile and embrasure form in the definitive prosthesis.

Figs. 11a to 11c: The clinical appearance of the gingival contours surrounding the implants and pontics prior to final cementation. Proper design of the provisional prosthesis will predictably maintain or profoundly enhances a pre–existing unfavorable soft tissue frame.

Figs. 12a to 12e: The definitive restorations following final cementation. The gingival frame including interdental papillae favorably influences the illusion of individual natural teeth.

Fig 13: The final radiographs of the completed case demonstrate the margin integrity and bone levels that will remain stable and continue to support the overlying soft tissue profile.

Fig 14a and 14b: A comparison of the definitive restoration and its outline superimposed on the pretreatment photograph using the same gingival reference point (blue arrow). Notice the relationship of the final prosthesis and soft tissue contours relative to the previous esthetic deficiencies.