The Profile Prosthesis: An Aesthetic Fixed Implant-Supported Restoration for the Resorbed Maxilla

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This article discusses a method for the predictable fabrication of fixed detachable maxillary reconstructions that abut and precisely follow the gingival contours — regardless of implant angulation or position. The technique reorders the traditional implant protocol and delays abutment selection until the definitive tooth position has been established. In this manner, final abutment selection and framework design become a single, integrated process that results in improved aesthetics, reduced angulation difficulties, and elimination of the phonetic concerns traditionally associated with fixed maxillary prostheses.

Osseointegrated implant therapy is routinely implemented with a high degree of success to solve functional difficulties associated with mandibular dentures used for the fixed reconstruction of the edentulous mandible.[1] While patients with minimal bone resorption seeking maxillary implant treatment can typically receive a functional, aesthetic fixed maxillary prosthesis,[2] the use of fixed restorations in patients with moderate to severe resorption is often discouraged by practitioners, who view this modality as unpredictable. As compared to the mandible, difficulties in the resorbed maxillary arch include reduced individual fixture and prosthesis survival percentages[3,4]; even with adequate bone for anchorage there is a greater need for bone grafting procedures to replace hard and soft tissue morphology,[5] and significant restorative challenges (eg, aesthetics, phonetics, hygiene) that result in the use of removable overdentures.[5-9] In sum, these difficulties affect patient acceptance and clinicians' confidence in fixed maxillary implant reconstruction as an elective treatment.

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In patients with moderate to severe resorption, these complications are typically related to poorly contoured denture-bearing areas, adverse jaw relationships, or significant loss of denture-bearing hard and soft tissue support.[5] In such cases, restoration requires not only the replacement of missing teeth; significant segments of missing alveolar bone and soft tissue must also be restored to natural contours.

While sufficient bone may be available, it is often located in regions that complicate the prosthodontic phase of treatment. The position of this bone tissue will be far palatal to the position the teeth must assume in the definitive restoration.[7] This creates prosthesis design complexities and potentially compromises not only the aesthetic result, but also hygiene access. In addition, encroachment upon tongue space and lack of tissue contact creates speech difficulties and patient discomfort.[7]

Design complexies are compounded when the patient does not have a low lip line. In patients with higher smile lines, abutment cylinders, interproximal spaces, and longer teeth are often visible.[8] The obvious solution — to cover the abutments with a prosthesis flange or an

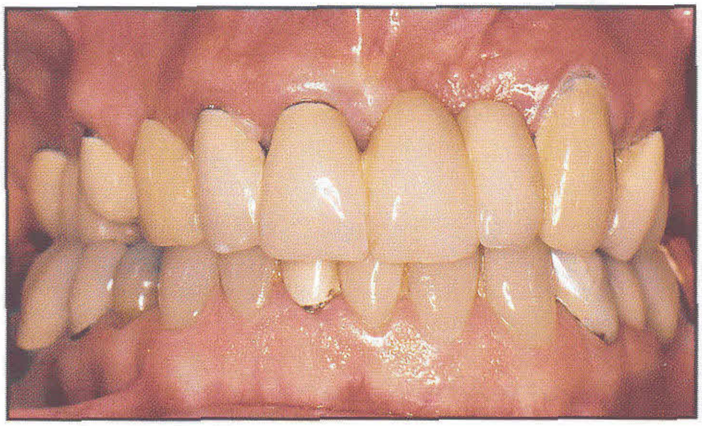

Figure 1. Preoperative facial view of a 56-year-old male. Note the porcelain fracture of tooth #5. Decay was evident on teeth #2, #4, and #12 that compromised the retention of the failing fixed partial denture.

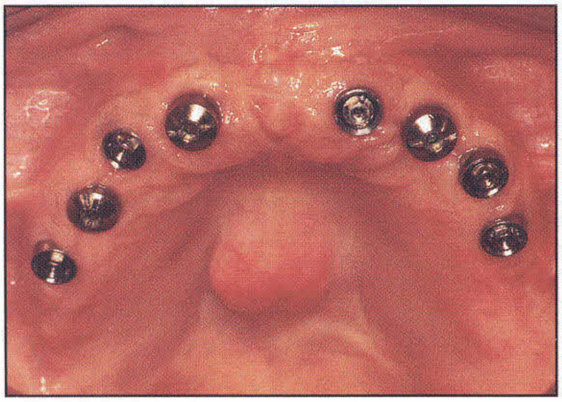

Figure 2. Patient wore a fixed detachable provisional prosthesis during sequential tooth removal and implant placement. Healing abutments and standard abutments were placed intraorally.

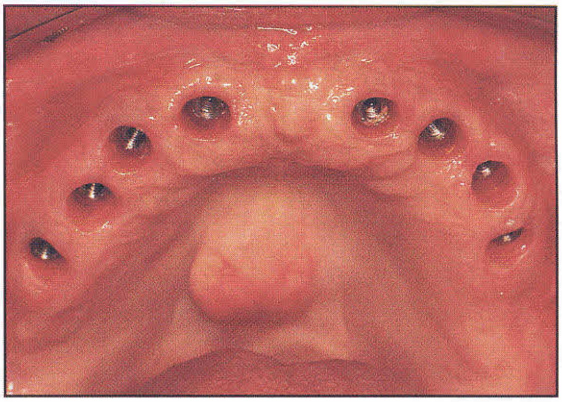

Figure 3. Occlusal view of the maxillary arch following the removal of intraoral abutments and prior to taking impression at fixture level.

artificial removable gingival-colored overlay[8,9] — results in compromised oral hygiene. Although the use of an implant-retained overlay prosthesis has been recommended, patient acceptance is low for removable prostheses.[8] If these aesthetic, phonetic, and hygienic complications could be resolved by the predictable placement of implants within the arch form of the teeth, maxillary reconstruction would presumably achieve increased reliability and usage. This article discusses a method for the predictable fabrication of fixed detachable maxillary prostheses that abut and precisely follow the gingival contours — regardless of implant angulation or position. When an implant cannot be placed into the position of the tooth root, the surgical emphasis must be to gain optimal anchorage for biomechanical support within the limits of restorability. The following method allows the surgeon greater flexibility for angulation and mesiodistal/buccolingual placement with minimal compromise of aesthetics and little difficulty in positioning the screw access hole. It uses concepts similar to those utilized in fixed partial denture prosthodontics (eg, diagnostic waxup, silicone matrix, wax cutback) and applies these techniques to traditional fixed detachable hybrid prosthodontics.[10,11] The patient described in the following section of this article experienced a failed maxillary reconstruction (Figure 1). In order to avoid an interim denture, implants were placed in a sequential implant / tooth removal procedure. This article addresses the final prosthetic phase of treatment.

Materials and Methods

Master Model Fabrication

As the procedure is presently practiced, healing abutments are placed following second-stage fixture exposure and the soft tissue is allowed to heal. When a fixed

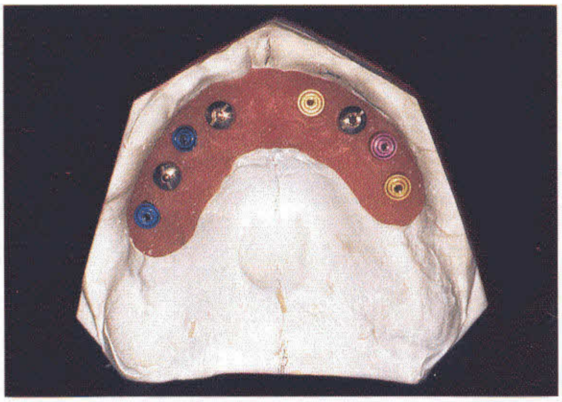

Figure 4. The impressions are utilized to fabricate a model of the soft tissues. The model replicated the position of the intraoral healing and standard abutments.

detachable provisional restoration is desired, several standard abutments can be placed to provide support for the prosthesis (Figure 2). After an 8-week healing period, all the abutments are removed (Figure 3), and an implant-level impression is made to provide a soft tissue model. Healing abutments and/or trial abutments are placed into the soft tissue model to exactly duplicate the components in the patient's mouth (Figure 4).

A light-cured provisional baseplate (Paladisc LC, Heraeus Kulzer, South Bend, IN) is stabilized using three cylinders that have been placed on selected trial abutments in a tripodal array. All other abutments are relieved so that the baseplate rests only on these three abutments, which will be used to stabilize the base during the evaluation of jaw relation records and try-in procedures. In order to verify complete intraoral seating, windows are placed into the base to visualize each abutment (Figure 5). If only

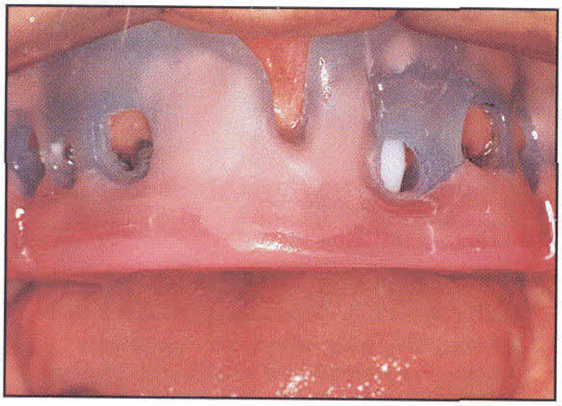

Figure 5. Three standard abutments were selected in a tripodal array to accept a screw-retained baseplate and wax rim to ensure the accuracy of interocclusal records. Note windows at abutments to confirm passive seating.

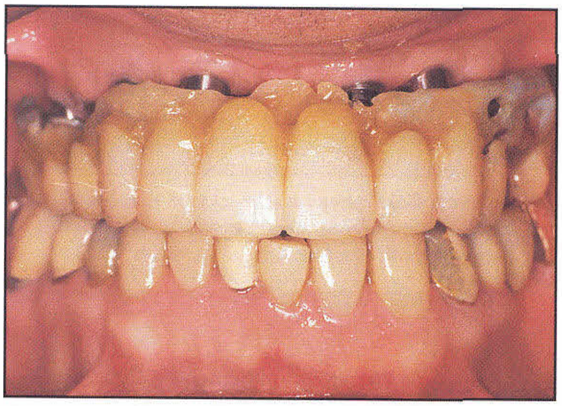

Figure 6. Facial view of waxed restoration, which was seated to permit assessment of aesthetics and function.

healing abutments were in place during the impression phase, three of these are replaced intraorally with standard trial abutments (Nobel Biocare, Yorba Linda, CA), in the orientation dictated by the master model to facilitate the taking of jaw relation records. When the patient is wearing a fixed provisional prosthesis supported by titanium abutments, the base is stabilized on three of these abutments. Once a wax rim has been added to the baseplate, jaw relations are recorded, and tooth selection procedures are performed.

Abutment Selection

The denture teeth are subsequently fabricated in wax and tried in for patient evaluation (Figure 6). Once the waxup has been approved, the border of the master model is keyed, and the setup on the model and keyed border is duplicated in stone. A vacuum-formed clear plastic matrix (Vacu-Press Disc, Dentsply International, York, PA) of the setup and the keyed border is subsequently fabricated. Following the fabrication of a silicone and stone matrix, the wax is boiled out, and the baseplate is removed (Figure 7). The denture teeth are retained in the silicone and stone matrix, and all abutment components are removed from the master model. Tissue depth is determined with a gingival simulation material (Softissue Moulage, Kerr/Sybron, Orange, CA) in place, and abutment heights are selected so that the margin of the gold cylinders will be 2 mm to 3 mm below the gingival margin. The gingival simulation material is then removed to permit visual access from the platform of the fixture to the final tooth position using the silicone and stone matrix (Figure 8). This vantage point provides superior control in the selection of abutments and framework design, and allows the clinician to properly orient screw access openings.

Using the silicone, the stone, and the clear vacuum-formed matrices, trial abutments are positioned on the master model with the objective of positioning the screw access openings within the buccolingual dimension of the tooth at least 3 mm from its facial aspect (Figure 8). A minimum of 2 mm should be present between the occlusal aspect of the gold cylinder and the tooth to allow for acrylic resin between the tooth and frame (Figure 9). The abutments should be positioned to allow for the formation of an emergence taper, a finishing line shoulder of 1 mm on each conical gold cylinder, and a minimum of 1 mm of interproximal space between shoulders. Twenty millimeter guide pins are subsequently attached to the trial abutments for precise determination of screw access emergence.

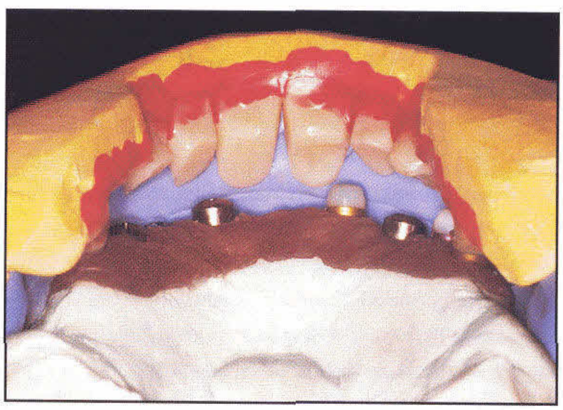

Figure 7. A silicone and stone matrix was fabricated on the model. The baseplate and wax were removed to leave the teeth in this matrix and to permit optimal visualization from the implant platform to final tooth position.

Framework Design

Critical to proper framework design is the establishment of a natural and gradual emergence profile with a 1 mm circumferential shoulder/finishing line at the gingival margin. The finishing line forms the junction between the acrylic resin and the framework. It should be sharp, definite, and where possible, undercut, in order to secure the resin in position similar to the design of removable partial dentures.[12] The gingival contours on the base of the gold cylinders are subsequently built up with pattern resin (GC Pattern Resin, GC America, Chicago, IL). Since the cylinders are placed subgingivally, pattern resin is more suitable than wax for defining the sulcular emergence profile as the gingival simulation material must be displaced during fabrication of the frame. In order to accomplish this, the conical gold cylinder is placed with a guide pin on the master cast with the moulage in place. Pattern resin is flowed onto the cylinder from its superior aspect in order to identify the gingival margin. The cylinder is then removed from the model. Pattern resin is added to establish a 1 mm shoulder that tapers 1 mm short of the apical margin of the conical gold cylinder. Once the supragingival portion of the framework has been completed, this gap will be finished in wax prior to casting. The cylinders are then replaced on the model with guide pins, forcing the gingival simulation material aside as they are fully seated.

Using the silicone and stone matrix that contains the denture teeth, the supragingival portion of the frame is completed in pattern resin and wax as necessary (Figure 10). The frame is designed 2 mm from teeth and soft tissue to allow for the resin material to completely encase the final frame. Once the frame design has been finalized and the abutment position on the master model has been confirmed, the wax/resin frame is removed from the model and set aside (Figure 11). Final waxing of the apical aspect of the conical gold cylinders and framework will be accomplished using a verification model fabricated at the final intraoral abutment placement.

Abutment Placement and Final Frame Fabrication

During preparation in the laboratory phase, an impression coping assembly is fabricated on the master model by adapting a light-cured material (Palatray LC, Heraeus Kulzer, South Bend, IN) to the impression copings that have been placed on the trial abutments in the master model. The material measures approximately 1 cm buccolingually, and is positioned 2 mm from the soft tissue; the assembly is separated between copings, leaving a 0.5 mm gap between all sections.

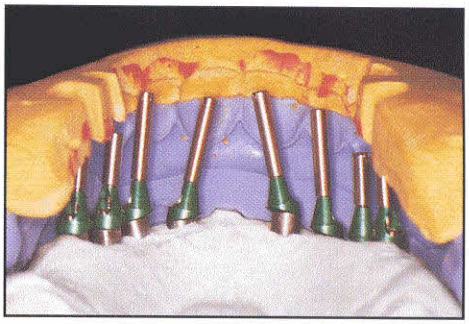

Figure 8. The trial abutments were placed in a manner that positioned the screw access openings within the buccolingual dimension of the tooth.

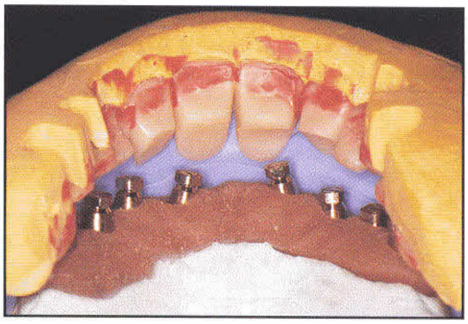

Figure 9. Gold cylinders were placed to confirm tissue depth and adequacy of occlusal space between tooth and frame.

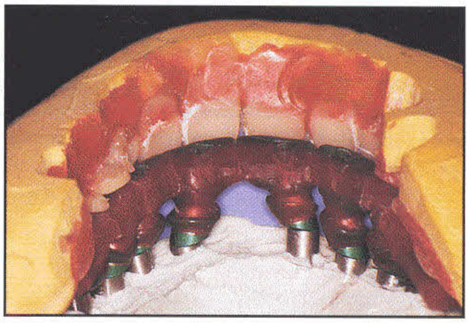

Figure 10. The framework was subsequently waxed to gold cylinders utilizing trial abutments and the matrix.

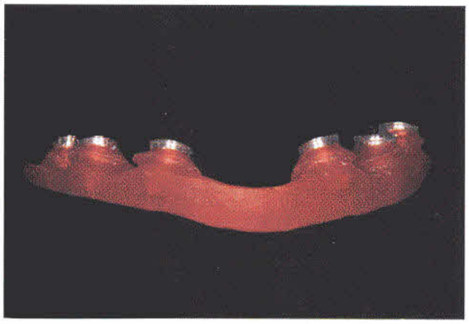

Figure 11. The resin framework was removed from the master model and set aside to await intraoral abutment insertion and subsequent verification model fabrication.

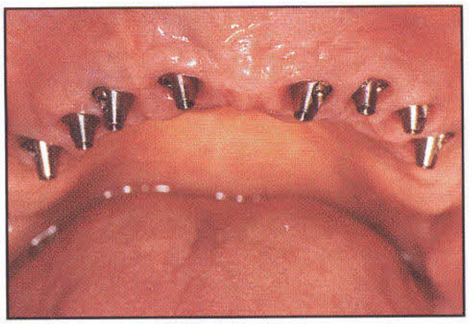

Figure 12. In accordance with the position of the abutment guide pins from the master model, the definitive abutments were placed intraorally.

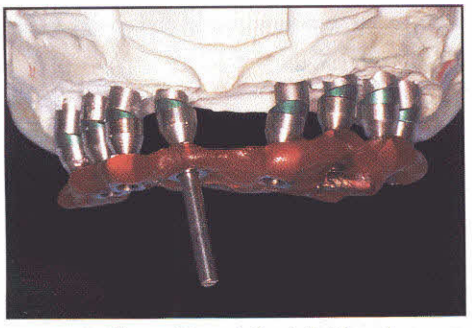

Figure 13. The position of the definitive abutments was verified intraorally and transferred to the master model.

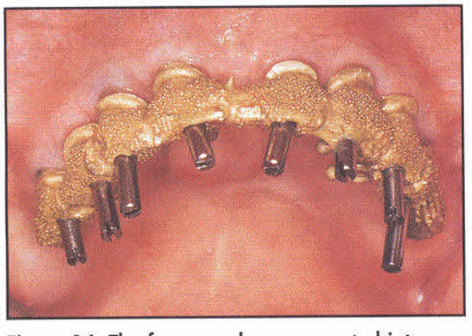

Figure 14. The framework was reseated intraorally to verify clinical fit.

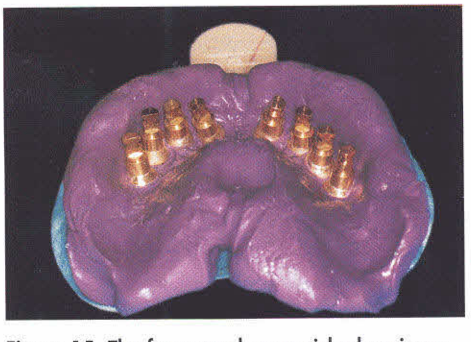

Figure 15. The framework was picked up in an impression to record its relationship to the established soft tissue levels, which may have changed from the first impression.

Utilizing 20 mm guide pins to visually orient their placement, the final abutments are positioned in the mouth precisely as the trial abutments are on the master model (Figure 12). The position of the final abutments is then verified with the master model by luting an additional set of impression copings (not those that have been used in the impression coping assembly) together intraorally with pattern resin and transferring these to the master model for verification (Figure 13). This process is continued one implant at a time until all final abutments have been placed according to the predetermined position on the master model. It is important that this procedure be completed with precision, as the framework was waxed to the trial abutments of the master model.

In order to provide an accurate verification model for the laboratory technician (which will be used for casting and soldering to ensure passive fit of the definitive framework), it is critical to relate the abutment seating surfaces together. An accurate registration of the abutment position is subsequently made using the impression coping assembly; the resulting verification model will be utilized to assemble the final frame in the laboratory. The registration is accomplished by placing the sectioned impression coping assembly intraorally with the gold screws (torqued to 10 Ncm) that will be used in the definitive prosthesis. The light-cured impression material sections (Palatray LC, Heraeus Kulzer, South Bend, IN) are connected with pattern resin, and the accuracy of the completed impression coping assembly is verified by loosening all but the most distal screw on one side and clinically or radiographically observing no interfacial gaps at the coping/abutment junction. The impression coping assembly is removed from the mouth and abutment replicas, held with pliers to avoid torquing the assembly, are placed into the copings using the gold screws, which are again torqued to 10 Ncm.

The tissue surface of the impression coping assembly is blocked out and its replicas are placed into a mounting stone (Whip Mix, Louisville, KY). When the stone has set, the impression coping assembly is removed, leaving a precise verification model that is used to assemble the final framework. The margins of the sectioned wax/resin frame that was set aside are finished in wax and placed on the verification model using the torqued retaining screws and the sections are reassembled on this model. Glass beads are added, the frame is sprued, invested, cast in type IV gold, and evaluated for passive fit on the verification model. The emergence profile/subgingival aspect of the frame is then polished in preparation for try-in and pick-up impression.

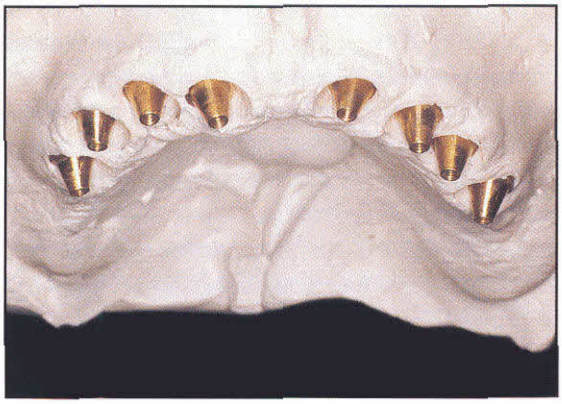

Figure 16. A hard tissue model was subsequently fabricated from the impression.

Figure 17. The framework was precisely adjusted and shaped to fit the hard tissue model and ensure optimal soft tissue adaptation.

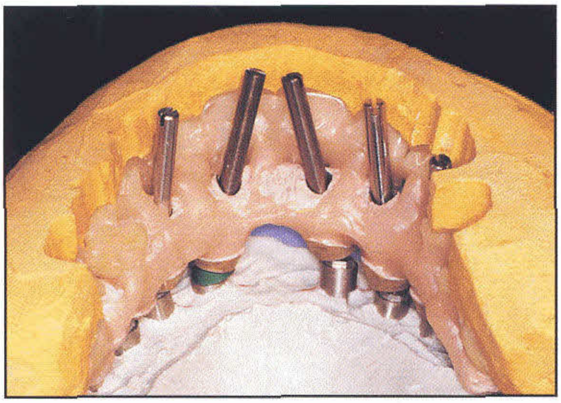

Figure 18. The opaqued framework was returned to the master model, and the setup was repositioned using the silicone matrix.

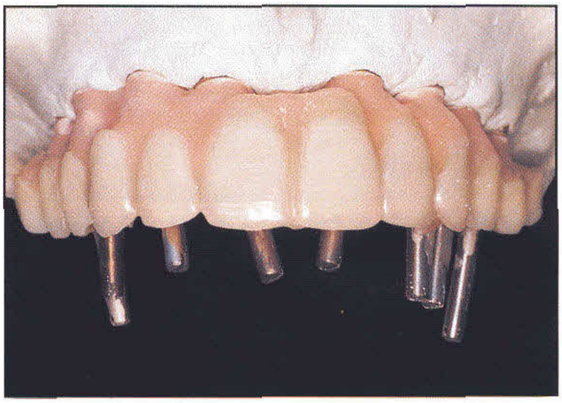

Figure 19. The framework that incorporates the teeth is subsequently returned to the hard stone for final waxing of its conical and emergence portions and adaptation to the soft tissue contours.

Frame Try-In/Waxing Model

The framework is tried into the mouth and passive fit is verified by gently tightening all screws to initial binding, then torquing each to 10 Ncm.[13] Less than one half of a turn should occur between initial bind and final torque.[13] The screws (except the most distal) are loosened again to permit clinical or radiographic examination for the absence of gaps at the cylinder/abutment junction (Figure 14).

The framework is picked up in a new impression using an open tray and guide pin technique (Figure 15); this relation of the framework to the soft tissue is poured in a hard stone model (Figure 16), which is utilized for adjustment of the finishing lines to the gingival margins and final waxup of the tissue surface of the prosthesis. Using the master model with trial abutments and the silicone/stone matrix, the framework is adjusted to allow a 2 mm clearance between the framework and the denture teeth (Figure 17). The framework is silicoated (Silicoater MD, Heraeus Kulzer, South Bend, IN) and opaqued (Visio-Gem Opaque, ESPE, Norristown, PA), and the teeth are transferred to the frame (Figure 18), which is then transferred to the hard tissue model for final finishing of the waxup (Figure 19). Jaw relation records are performed, and patient approval of the final waxup is obtained (Figure 20). The prosthesis is processed, finished, and delivered (Figures 21 through 24). Two weeks following the seating of the prosthesis, it is removed and any pressure points are relieved.

Results

Since 1995, 7 patients have been successfully treated with 12-unit fixed detachable maxillary prostheses using this fabrication protocol. One patient had previously worn a standard hybrid prosthesis; a second was converted from a complete denture. In addition, two other patients were converted from fixed partial dentures and three from

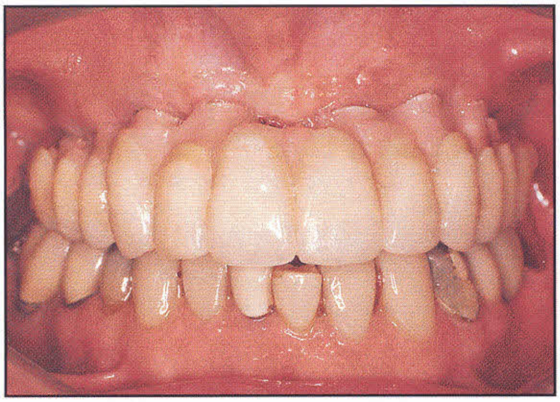

Figure 20. The intraoral try-in is completed, and the restoration is prepared for processing.

Figure 21. The acrylic-wrapped framework design was visible prior to insertion. Note the pontic-like adaptation of the acrylic to the soft tissue, without any ridge laps or other hygienic compromise.

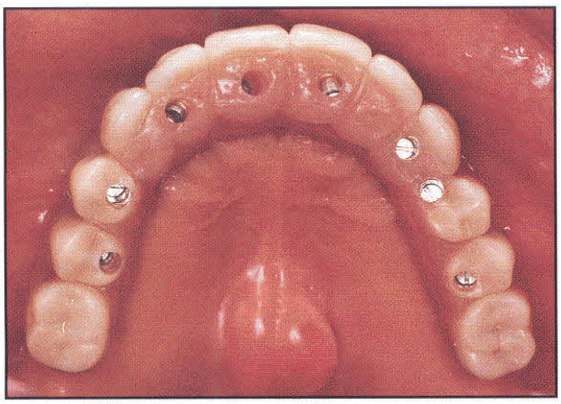

Figure 22. Occlusal view demonstrates the control of the screw emergence gained by abutment selection as a laboratory exercise following the establishment of final tooth position.

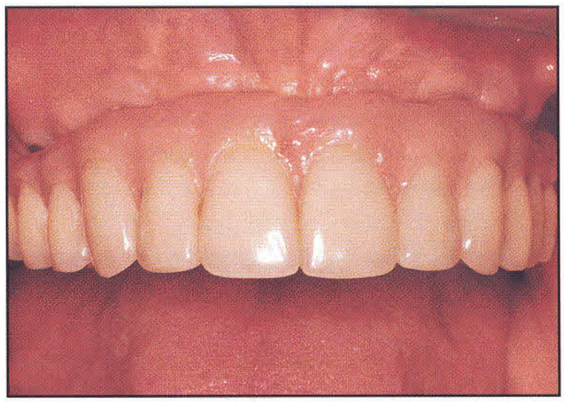

Figure 23. Postoperative facial view of the implant-supported prosthesis. Note the manner in which the prosthesis precisely abuts the gingival contours as it replaces the alveolar morphology.

removable partial dentures, respectively. To date, phonetic complications have not occurred for any of the 7 patients, nor have they experienced resin fractures or soft tissue inflammation. These fixed detachable prostheses were supported by 43 implants (Nobel Biocare, Yorba Linda, CA) placed anteriorly to the maxillary sinus. One of the patients with 5 implants experienced screw loosening following 3 years of function. In this patient, one distal unit was prophylactically removed from the prosthesis bilaterally to shorten the cantilevered extensions.

Discussion

Benefits of the Profile Prosthesis

Full maxillary porcelain implant-supported reconstructions have been accomplished with excellent results in cases with minimal resorption where implant position and tooth length can be idealized without significant soft tissue deficits requiring larger frameworks.[2] In patients with moderate to severe resorption, however, replacement of lost alveolar morphology and conventional tooth length in one-piece porcelain-fused-to-metal restorations requires very large frameworks that are subject to distortion upon repeated firing and consequently require exceptional technical aptitude to accurately fabricate.[2,14] Alternately, this restorative modality enables patients with moderate to severe resorption to receive biologically contoured fixed detachable prostheses that provide significant aesthetic and phonetic advantages. Delaying abutment selection until the final tooth position has been established increases operator control of framework design, which results in precise placement of screw access hole location, the ability to follow biological contours with great detail, and maximum analysis opportunity and flexibility to solve angle and implant proximity discrepancies. Since the prosthetic design is initiated with subgingival emergence of the conical gold cylinders, a natural extension of the framework and resin to the tooth position is achieved. Consequently, this procedure addresses the soft and hard tissue deficits associated with alveolar ridge loss and subsequent lip support and facial profile without requiring a denture flange or removable artificial gingiva (Figure 25). Since the acrylic resin and teeth can be easily repaired or replaced as necessary, this prosthesis design can be utilized for long-term function. This restorative technique can also be predictably and successfully utilized in the mandibular arch. Eight mandibular 12-unit fixed detachable prostheses have been placed with similar results to those achieved with the maxillary prostheses. This interdisciplinary treatment provides an effective solution for the reconstruction of the resorbed totally edentulous maxilla and mandible as an alternative to grafting solutions that build up tissue deficits. Accordingly, this technique may be successfully used with edentulous resorbed jaws. It is of particular usefulness in situations when the patient declines the utilization of bone regeneration or grafting procedures to provide ideal contours for porcelain restorations as is demonstrated by the restoratively driven concept for the partially edentulous patient.[15-18]

The most effective use of this procedure is in instances where the junction of the soft tissue and the prosthesis is concealed by the lip, which allows the surgeon to reduce and flatten ridges to maximize implant support. Since this restorative procedure requires adequate space to accommodate the framework design, it is difficult to use in patients with limited intra-arch dimensions. Adequate space must be provided for the formation of the cone and shoulder/finishing line, the narrow vertical chimney (for resin wrapping), and the occlusal connecting bar which is triangular and should be 4 mm high and 4 mm wide at its base. In addition, the distance between the top of the bar and the occlusal plane must be 3 mm. This procedure is most effective when using conical gold abutments (EsthetiCone, Nobel Biocare, Yorba Linda, CA) because of its height. Since the reduced height of the gold cylinders does not allow for the formation of the cone and shoulder below the top of the cylinder, the technician also has limitations when using short abutments (eg, Standard or MirusCone, Nobel Biocare, Yorba Linda, CA). This may result in a weakened frame in the chimney area, although the author has determined that it is possible to address this potential complication by connecting the collars interproximally. In instances of reduced interarch space and/or a sulcus depth of less than 3 mm and angle correction is not necessary, a UCLA abutment can also be utilized.

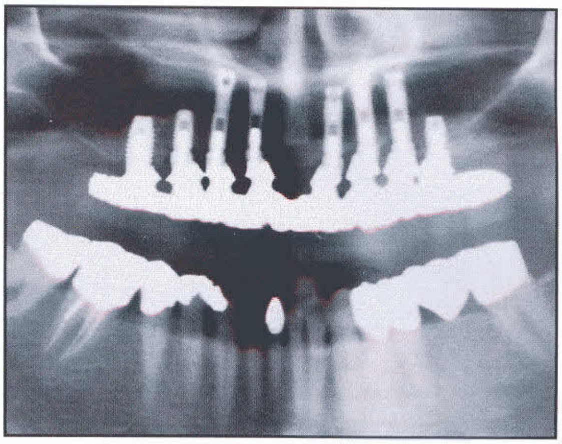

Figure 24. Radiograph of the patient following the delivery of the prosthesis. Note the conical framework emergence with cutback to accept the acrylic wrap at the soft tissue level.

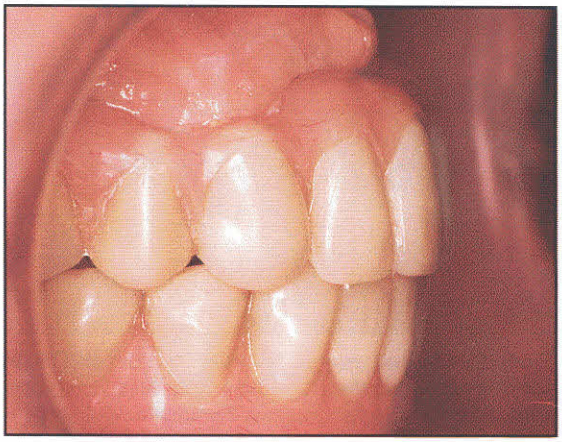

Figure 25. Soft and hard tissue defects associated with alveolar ridge resorption and subsequent loss of lip support can be addressed without requiring flange or ridge-lap extensions.

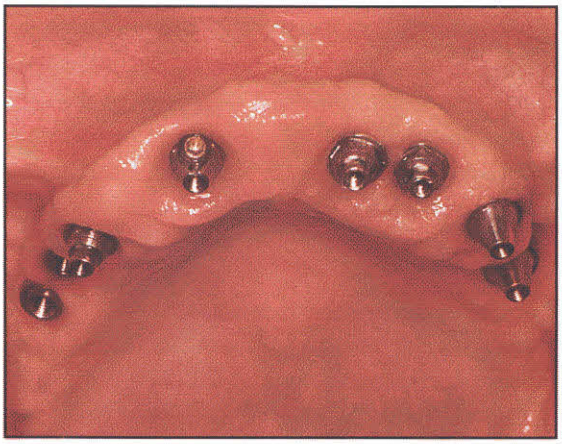

Figure 26. Occlusal view of a patient 10 months postoperatively. Note the healthy status of the tissues.

The selection of abutments following establishment of tooth position allows the optimum choice for occlusal height, soft tissue sulcular depth, and degree of angulation. This procedural revision permits the clinician to significantly reduce the bulk of the prosthesis so that the access holes can generally emerge within the buccolingual dimension of the teeth, regardless of implant angulation. Implant abutment selection is more precise when determined by final tooth position and matrix in the laboratory as opposed to conventional techniques that utilize the tissue-supported surgical guide (previously used at implant placement) after second-stage surgery without the natural teeth as landmarks to guide intraoral abutment selection and placement.

In terms of hygiene concerns, tissue contact is similar to the pontic area of several missing teeth in a conventional tooth-borne fixed prosthesis, and is analogous to a long pontic. While significant calculus and plaque accumulation on the tissue-facing surface has been observed with the standard hybrid prostheses, the aforementioned prosthetic design permits optimal hygiene and tissue health to be maintained (Figure 26). Mastery of this technique eliminates uncertainty in the fabrication of the prosthesis. In the past, particularly when angled abutments were involved, one of the difficulties had been the clinical assessment of fit since margins are generally subgingival. Using the revised method, fit can be determined with accuracy since passivity can be felt with screw-tightening procedures.[13]

While the procedure extends treatment duration and requires numerous components, it actually reduces chairtime since the entire framework fabrication and abutment selection and position are performed in a laboratory once tooth position is determined. The selection of abutments chairside frequently results in discarded abutments and cannot achieve the precision afforded by the aforementioned technique, since the technician is able to confirm abutment position during the initial framework design phase, prior to final abutment insertion.

The interaction of laboratory technicians is essential since the procedure requires the collaboration of the denture and framework departments. The finishing process — specifically, application of waxing, design of the prosthesis and application of acrylic — involves significant collaboration between the two departments. In addition, the volume of available information demands a clear understanding of abutment selection principles. From the clinician's standpoint, however, the process is easier and more controllable, which often results in an improved outcome.

Conclusion

Although admittedly time and component intensive, many of the techniques used in this prosthesis design are applicable to smaller and less complex reconstructions. The technique can be used virtually anywhere fixed detachable reconstructions are used — whether porcelain or hybrid, whether three-unit or a large construction — with significant rewards. By delaying abutment selection until the final tooth position is determined rather than making judgments on the basis of visual appearance and tissue height, abutment selection in the laboratory can be virtually foolproof, resulting in an aesthetically pleasing maxillary restoration free of implant angulation, phonetic or hygienic difficulties.

Acknowledgment

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