Full Mouth Restoration on Dental Implants Utilizing Titanium Laser-Welded Frameworks

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ABSTRACT

In today's dental literature, most frequently, esthetics are addressed with fixed restorations. This article will illustrate the opportunity to provide our patients with very good esthetic outcomes with a hopeless dentition utilizing dental implants, laser-welded titanium components, and characterized acrylic resin prostheses. The definitive prostheses provide excellent facial support, phonetics, esthetics, smile line, and function. The steps in such a treatment will be presented from the clinical to dental laboratory procedures.

CLINICAL SIGNIFICANCE

Incorporating newer technology into our patient treatment plans, which increasingly includes dental implants, may allow more time-efficient, esthetic, predictable, and reliable treatment. Laser-welded titanium frameworks offer many advantages for the patient, clinician, and dental technician, which are illustrated.

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INTRODUCTION

Originally, dental implants were considered a "last resort" for treatment of the edentulous patient. As implant dentistry progressed, the original Brånemark protocol required long healing periods of several months for osseointegration to take place before beginning fabrication of the definitive prosthesis.[1] Many changes in restorative and surgical protocol, microscopic and macroscopic implant surface treatments have resulted in a significant reduction of healing time and decreased patient treatment time.[2]

With these improvements, however, there are still challenges facing the patient, practitioner, and laboratory technologist. These can be but are not limited to: patient expectations, oral anatomy, patient finances, practitioner knowledge and clinical skills, laboratory skills, and available biomaterials for fabrication of the planned prosthesis.[3–5]

Patient expectations are a major concern for implant practitioners. Frequently, there are hard and soft tissue compromises in the so called "esthetic zone" that preclude optimal results with some fixed prosthetic restorations. Many edentulous maxillas can be treated with dental implants and restored with over-dentures that result in a very cosmetic restoration. Significant residual ridge resorption can be compensated for by the labial flange and tooth positioning to provide optimal maxillary lip support, smile line, and facial support. The implants can provide retention and stability to the removable prosthesis in addition to the benefit of preserving the alveolar bone due to the presence of dental implants in the area.

Implant overdenture therapy has been utilized successfully for at least two decades with high success

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rates.[6] With the development of new technologies and use of new materials, many overdentures are now able to be fabricated without a palate and are very stable and retentive.[7–9] This has several advantages to the patient such as improved taste and temperature sensation and a less bulky prosthesis, which may provide improved speech patterns for some patients. Multiple implant attachment options have been utilized successfully over the years.[8]

Mandibular implant-supported fixed bridges for the edentulous were treated by the early Brånemark protocol with the placement of 5–6 dental implants and restoration with a traditionally waxed and cast gold framework to which the dental technician could process either composite or acrylic resin materials.[1] These types of restorations were very successful but with the escalation in the cost of gold, this may render them somewhat obsolete. There are several methods for utilizing CAD-CAM technology for fabrication of some of these frameworks.[10–12] This article will describe patient treatment with dental implants in both the maxillary and mandibular arch and restored with titanium laser-welded prostheses. The maxilla is restored with a Hader bar-supported palate-less overdenture and the mandible with screw-retained fixed bridges. The advantages over the previous lost wax/gold casting techniques are several. The technician saves time by utilizing prefabricated titanium components resulting in improved fit and biocompatibility, a very strong restoration, and use of a current technology that is well researched and today, routinely available, compared with some CAD-CAM (computer aided design-computer aided manufacturing) systems.[13–15]

PATIENT TREATMENT

A 62-year-old female presented for evaluation of her failing dentition. She was interested in improved esthetics and function. Her health history was noncontributory. Clinical examination revealed generalized probing depths of 4–8 millimeters, mobile dentition, malocclusion, and generally a nonrestorable dentition (Figure 1A and B). Evaluation of her radiographs showed significant destruction of the supporting osseous structures, many failing restorations, and recurrent caries. Observation of the mounted diagnostic

Figure 1. A and B, *The patient's pretreatment dental condition, noting defective restorations, periodontal disease, and tooth malposition.*

casts revealed a compromised occlusal relationship.

The patient was very opposed to the proposal of complete denture treatment, as she had previously unsuccessfully attempted to wear a mandibular removable partial denture. After further consultation of the patient with the prosthodontist and an oral surgeon, the patient was presented with a plan that would include extractions, fabrication of interim complete dentures, healing of 3–6 months, a diagnostic wax up and fabrication of a surgical guide, implant placement of 6 SPI Element 4.5-mm implants (Thommen Medical, Cleveland, OH, USA) in each the mandible and maxilla. The definitive restorations would be a mandibular-fixed prosthesis and a maxillary bar-supported, palate-less, removable complete denture.

A detailed discussion was completed with the patient describing the advantages and disadvantages of treating the edentulous maxilla with moderate/severe residual ridge resorption of both fixed and removable prosthodontics. The advantages of significantly increased stability and retention with six maxillary implants and a supporting Hader bar were accepted by the patient. Additionally, it was felt the patient could

Figure 2. A, B and C, *Mounted diagnostic casts and the patient-approved trial wax arrangement following extractions and healing before implant placement to verify appropriate tooth position, phonetics, and esthetics. The silicone putty index assisted in determining the patient would be best treated with an implant supported overdenture due to the amount of alveolar ridge loss and the need for facial support provided from the denture flange.*

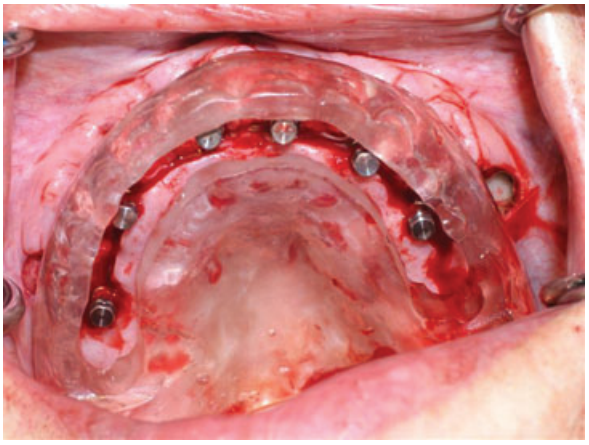


Figure 3. Surgical guides fabricated from the diagnostic trial wax arrangement utilized in the definitive implant placement in both the maxillary and mandibular aches in the proper predetermined positions.

Figure 4. Clinical appearance of the maxillary soft tissues following a 6-week healing period, illustrating good hygiene and patient compliance to maintain oral health.

more easily complete the required hygiene techniques for the maxillary bar rather than a fixed prosthesis with a pontic ridge lap design. The maxillary removable prosthesis was selected as the patient required facial and lip support from the complete denture flange for optimal esthetics as determined from the edentulous wax-up and try-in phase of treatment.

Maxillary and mandibular immediate complete dentures were fabricated prior to extraction of all of the patient's remaining teeth. The teeth were extracted uneventfully and the ridge contoured for optimal implant placement following initial healing. The dentures were delivered, the patient was given routine instructions, and she was comfortable with the understanding that the prostheses were considered interim.

Following a 3-month healing period, a diagnostic mounting and wax up was completed for definitive evaluation of occlusal vertical dimension, interarch distance, centric relation, and very close evaluation of the patient's esthetics requirements (Figure 2A–C). The patient approved the esthetic tooth arrangement, and surgical guides were fabricated by duplicating the diagnostic esthetic tooth arrangement (Figure 3).

A discussion with the surgeon resulted in the surgical guide design allowing wide-spread placement of the implants in an optimal position for tooth placement and spacing for restorative components. Following implant placement, the immediate dentures were relieved and a soft tissue conditioner was placed in each denture so the patient could comfortably wear the prostheses during the healing period. All implants went to place with an appropriate torque and no mobility. The surgeon determined adequate healing to begin definitive impressions that would be satisfactory 6 weeks from initial placement.

The patient healed adequately and at 6 weeks, the restoration process was begun with preliminary impressions from which open design custom impression trays would be fabricated (Figure 4).

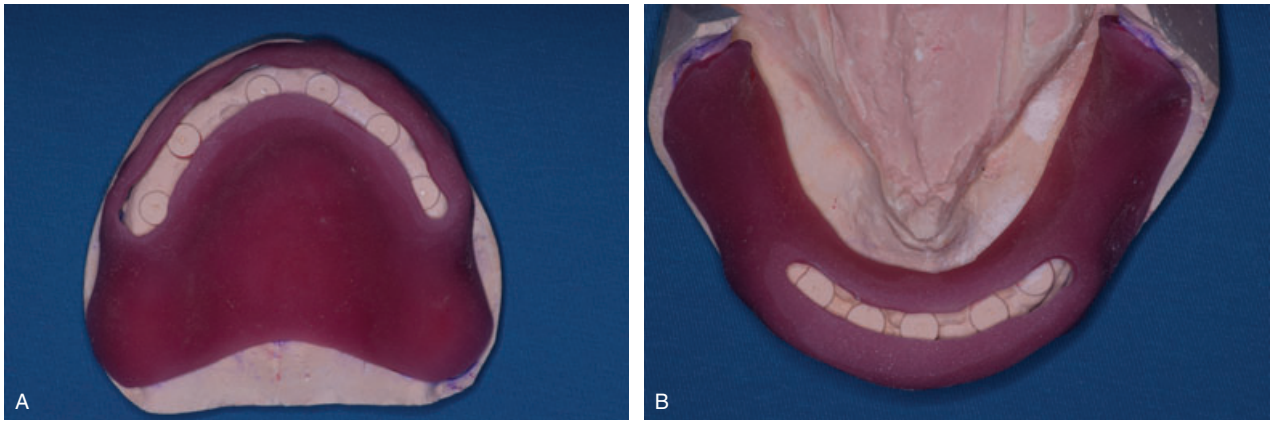


Figure 5. A and B, *Open custom impression trays fabricated for final impressions from the preliminary impressions. This will facilitate direct impressions of the SPI Element implants versus an abutment level impression.*

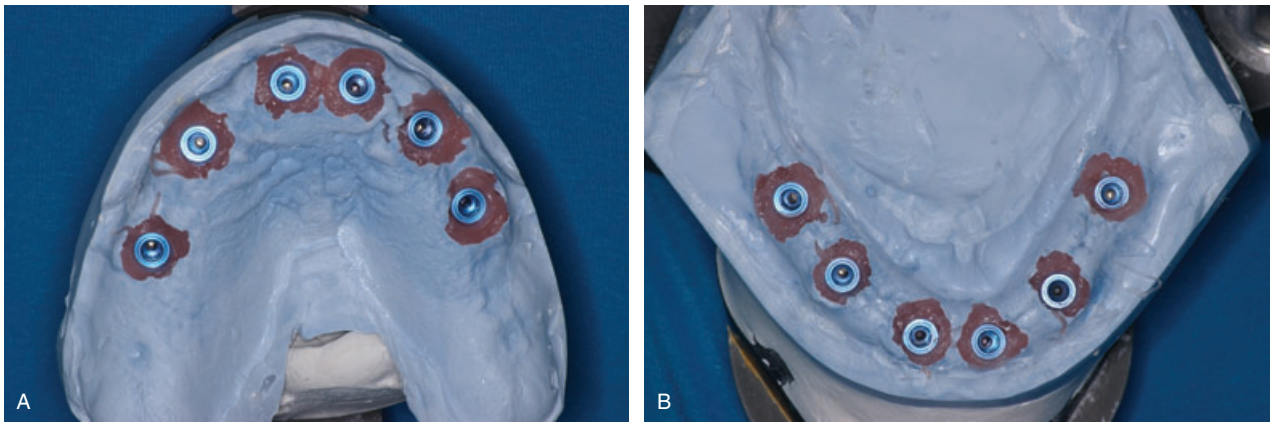


Figure 6. A and B, *Resultant master casts poured in a type V improved dental stone.*

The custom trays were utilized for implant level final impressions using a poly-vinyl siloxane impression material (Figures 5A and B, 6A and B). The following appointment, trial bases with occlusion rims were routinely adjusted for lip support, phonetics, esthetics, and determination of appropriate occlusal vertical dimension and centric relation (Figure 7). The final shade and mould of the prosthetic teeth were verified with the patient's assistance along with the shade of the gingival acrylic resin. At this appointment, a verification index was tried in each arch following removal of the healing caps (Figure 8A and B). The verification index will prevent the necessity of another appointment for framework try-in by allowing the clinician to determine that the final impression and master cast are absolutely accurate. If the verification index does not go to place accurately, the final impression should be remade. Occasionally, if there is a discrepancy that is minimal, the restorative clinician has the option to cut and readapt the index intraorally and

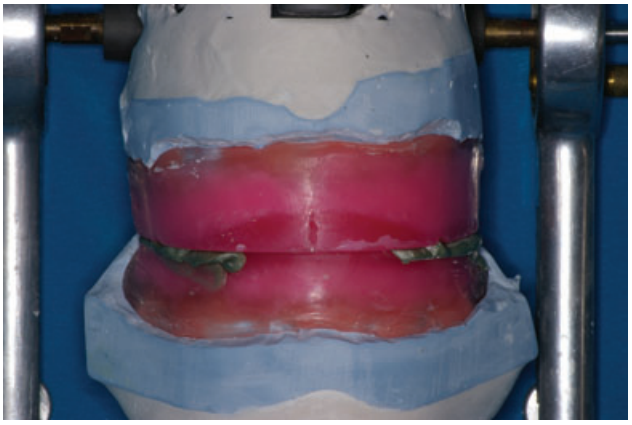
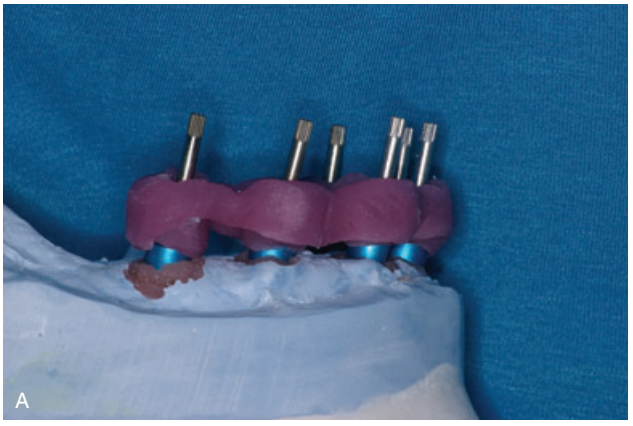


Figure 7. In the dental laboratory, trial bases with occlusion rims are fabricated directly on the master casts. The author provides the laboratory with duplicate size healing caps so the trial base will fit the mouth exactly as it fits the master cast. The maxillo-mandibular relations are completed in a normal manner along with prosthetic tooth selection.

Figure 9. At the wax try-in appointment, the patient will be able to verify the esthetic arrangement, tooth display, tooth shade, facial support, phonetics, etc.



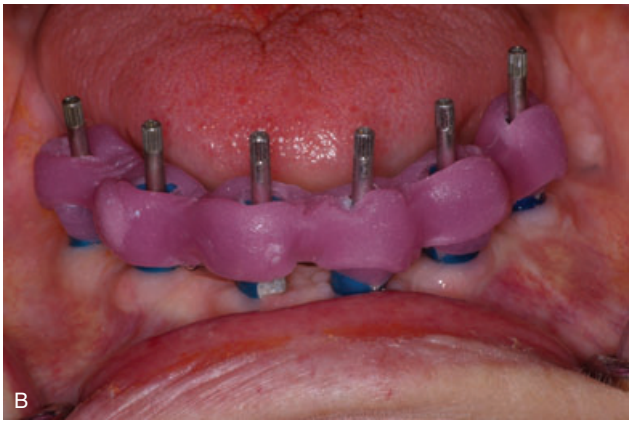


Figure 8. A and B, *Verification indices are fabricated on the master casts utilizing the appropriate impression copings luted together with VLC acrylic resin (Triad, Dentsply, York, PA, USA). The verification indices should go to place passively and accurately when tried in the patient's mouth at the try-in appointment.*

correct the master cast by removing the offending laboratory analog and replacing it through the corrected verification index.

The mounted master casts now allow the technician to perform an accurate wax arrangement of the prosthetic teeth for the clinician and patient evaluation (Figure 9). At this appointment, the clinician should be evaluating occlusal vertical dimension, centric relation, facial support, anterior tooth position for optimal phonetics and esthetics, occlusal plane orientation, etc.[16] The patient will be asked to evaluate anterior tooth color, shape, size, and facial support. When approved, the wax up can then be returned to the

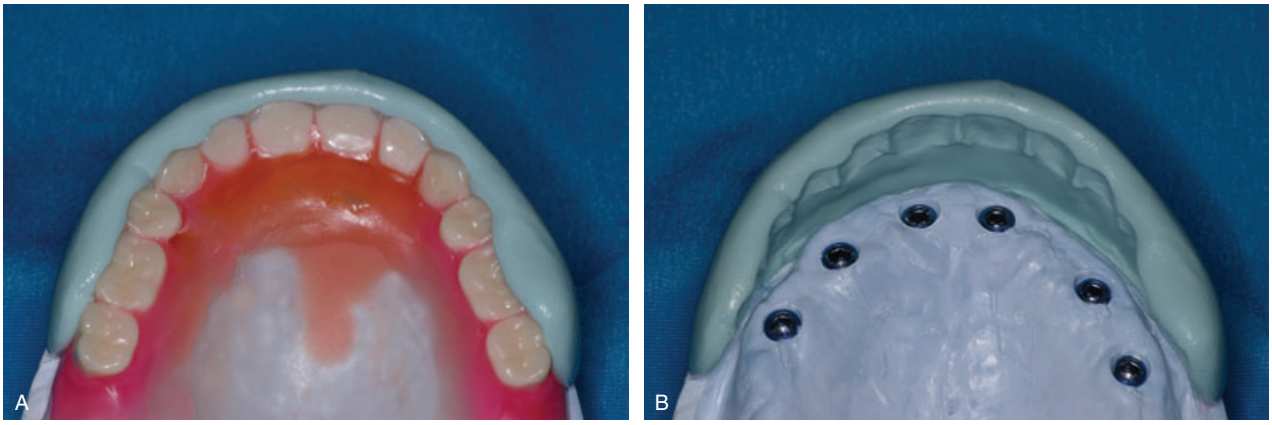


Figure 10. A and B, *Following the patient's approval of the wax set-up, the dental laboratory can fabricate a silicone index to aid in the proper contours and design of the definitive prosthesis in relationship to the teeth without distorting the palatal contours of the maxillary arrangement.*

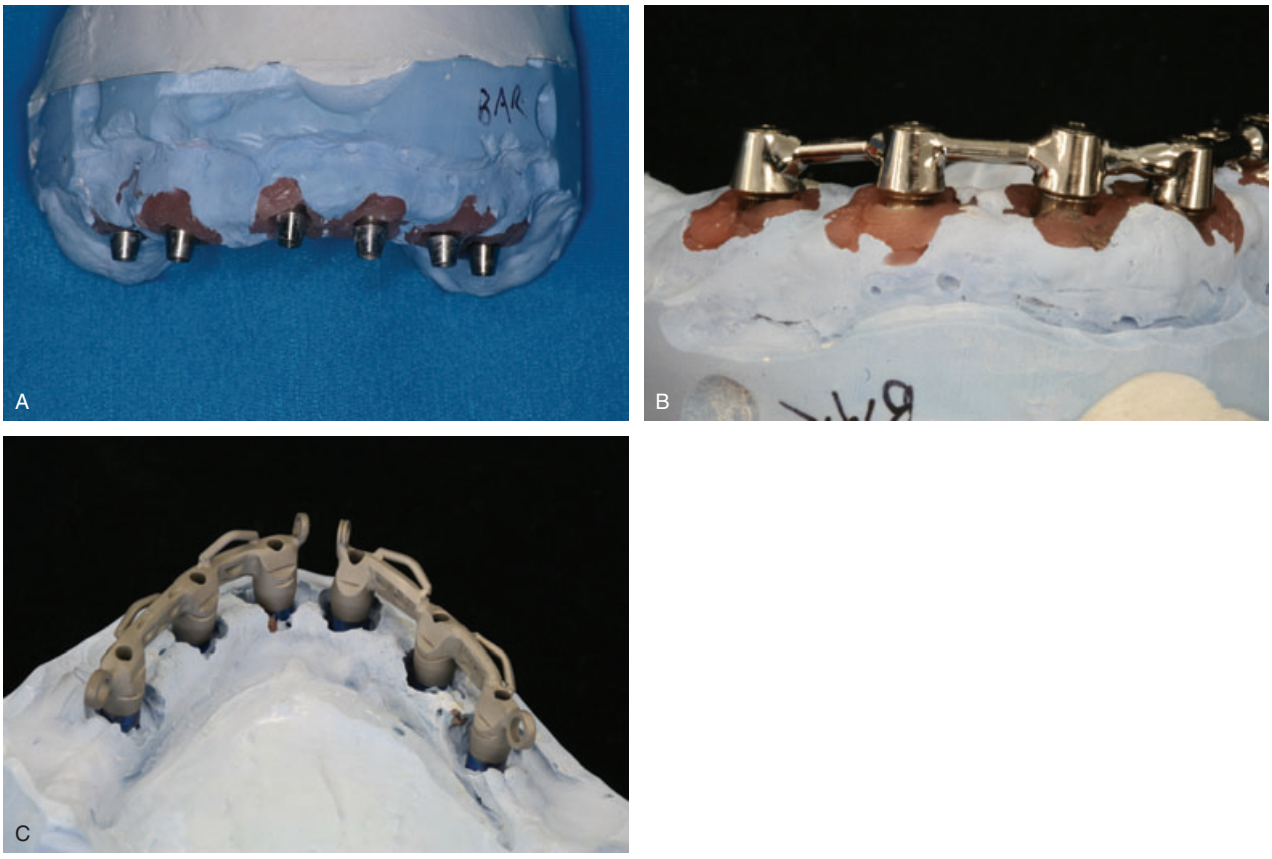


Figure 11. A, B and C, *The dental technician can now select the proper bar supporting abutment (Retain, SPI, Thommen Medical, Cleveland, OH, USA) and titanium coping for the abutment. Milling abutments (Thommen Medical) were selected for the mandibular arch because they are easily milled and welded to titanium stock to retain the processed acrylic resin prosthesis. The components can then be laser welded with the maxillary titanium Hader bar and mandibular fixed prosthesis directly on the master casts resulting in a very accurate fit.*

laboratory for fabrication of the definitive prosthesis framework and processing and characterization of the acrylic resin.[17,18]

LABORATORY PROCEDURES FOR THE DEFINITIVE FRAMEWORKS

Previous traditional frameworks for implant-supported prosthetics include waxing the prosthesis, investing the wax up, utilizing the lost wax method converting the invested wax up to a metallic casting. This can be time consuming and extremely technique sensitive, as the frameworks have several critical steps dependent on dimensional stability of wax, gypsum investment, oven temperatures, and the melting and solidification of metal alloys commonly used in dentistry. Occasionally, these frameworks do not accurately and passively fit the master cast following casting and require sectioning and soldering to provide for an optimal fit to the master cast.[19] Again, this can be time consuming and costly due to the increase in time and effort by the dental technician.

Today, the implant companies manufacture titanium components that can be utilized with today's improved laser welding technology. Laser welding is an extremely accurate procedure that allows the dental technician to fabricate a very strong and biocompatible metal prosthesis directly on the master cast, helping to ensure a passive fit.[13]

An index is made of the final tooth wax up to facilitate optimal design of the framework in relationship to the appropriate tooth position (Figure 10A and B). The technician then can fabricate the frameworks from titanium components and assemble them with laser welding in an inert atmosphere to prevent corrosion and weak joints. The laser welds and titanium frameworks are not only biocompatible due to their titanium composition but the laser welds are also frequently stronger than their "soldered" counterparts in addition to being much lighter due to the decreased specific gravity of titanium versus gold alloy. Given the cost of gold today (over $1,000 an ounce), the titanium frameworks can also be less expensive.

Because an implant level final impression was made, the dental technician was able to select the appropriate abutments for the final prosthesis (Figure 11A–C): a screw retained Hader bar for the maxilla and a screw retained fixed prosthesis in the mandible. The mandibular fixed bridge was fabricated in two pieces because the most distal implants were placed in the first molar area. There is a consideration that mandibular flexure could be a long-term problem if a rigid framework is placed, resulting in possible biomechanical failure of components.[20–23]

The mandibular frameworks are opaqued and processed in high-impact acrylic resin and

Figure 12. The author routinely requests that the technician utilize a pink opaque on the mandibular framework to mask the grey color of the metal and provide a more esthetic restoration.

Figure 13. A, B, C and D, *The completed prostheses returned from the dental laboratory for inspection prior to delivery to the patient.*

characterized for improved esthetics (Figure 12). The edentulous areas of the mandibular prosthesis were designed to be similar to a modified ridge lap pontic to facilitate optimal hygiene procedures and help prevent food impaction. The maxillary overdenture is also processed in the same shade acrylic resin as the mandible and also characterized for optimal esthetics. The titanium Hader bar is also designed to optimal positioning beneath the prosthetic teeth to not interfere with palatal contours or prosthetic tooth positioning. Adequate bar position is also possible to provide optimal access for oral hygiene.

The restorations were returned finished from the laboratory, along with the maxillary abutments (Figure 13A–D). The titanium milling cylinders were incorporated into the framework and would allow the mandibular prosthesis to be placed directly on the implants. The healing caps were removed and the abutments/bar and prosthesis were tried in and a seating radiograph was taken. Following verification of passive fit, the prostheses were put to place and the retaining screws torqued to the appropriate value (Figure 14A–C). An occlusal remount could be accomplished but the procedure has been very accurate to this

Figure 14. A, B and C, *The maxillary healing caps are removed, maxillary abutments placed along with the Hader bar and torqued to place. The mandibular healing caps are removed and the mandibular split midline prosthesis is torqued to place. Before torquing the prostheses to place, the author will verify the occlusal relationship and make any necessary adjustments and repolish the prosthesis where necessary. Right and left lateral views and frontal view with lips retracted.*

point and the occlusal adjustment was extremely minimal.

Oral hygiene was demonstrated for the patient and she was able to perform the required procedures quite well. Routine postdelivery instructions were given and the patient was appointed for follow-up (Figure 15A and B). The patient has been problem free for over 3 years with no soft/hard tissue problems or concerns with the titanium laser-welded framework (Figure 16).

CONCLUSION

Use of current techniques and materials allow improved patient treatment with dental implants. The lost wax method has been the basis for the majority of indirect dental restoration fabrication procedures for well over a hundred years. Improved technology can provide the treating practitioner a means to delivery superior prosthetics in a timely manner that may be superior to that which we have all become accustomed. Utilization of new technology will allow improved and predictable treatment for our patients. Esthetics, function, and comfort for the patient have

Figure 15. A and B, *The patient's smile with the wax trial denture and with the definitive prostheses in place. Note no noticeable changes in development of smile line or lip and facial support.*

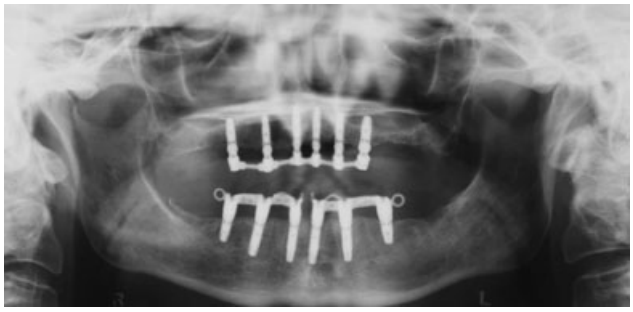


Figure 16. Panoramic radiograph taken 3 years postdelivery illustrating stable bone levels around the restored implants.

been addressed in a predictable and reliable manner due to adaptation and utilization of newer components and technologies.

DISCLOSURE AND ACKNOWLEDGMENT

Dr. Schneider has occasionally lectured for Thommen Medical, for which he received honoraria.

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