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1hr

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Forging Optimal Patient Rehabilitation

Fabrication of a Laser Welded Titanium Framework Supported by Dental Implants

By **Danny Roberts, CDT, and Robert L. Schneider, DDS, MS.**

Tumor removal from the mandible may involve many portions of the cheek, teeth, tongue, alveolar ridge and lip. The loss of any or part of these structures may include the loss of a significant tooth-bearing segment of the jaw.

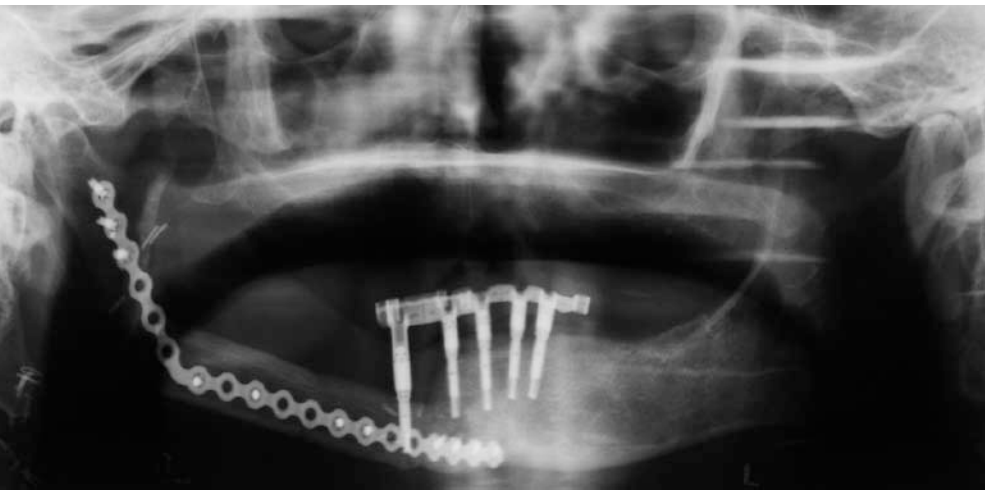

Figure 1

Radiograph of implants placed in to the native mandible and neo-mandible along with the reconstruction reinforcement bar.

This article describes a patient rehabilitation utilizing an osteocutaneous microvascular fibula free ap following removal of a malignant lesion of the mandible. The dental rehabilitation consisted of placement of osseointegrated root form dental implants followed by the fabrication and restoration with a titanium laser welded framework supporting an acrylic resin processed fixed-detachable hybrid prosthesis opposing a maxillary complete denture.

The use of a titanium laser welded framework was chosen because of:

1. Superior passive fit compared to conventional cast frameworks.
2. Strength.
3. Biocompatibility.
4. The increased cost of gold.
5. Precision of milled components.[1,2]

The acrylic resin injection polymerized type prosthesis was selected for the relative ease of fabrication, less complicated future repair when indicated compared to a porcelain-fused-to-metal restoration and the ability to simulate the lost gingival and appropriate tooth form. Additionally, the use of compatible opposing prosthetic teeth made establishing an acceptable occlusal scheme with the slightly atypical maxillo-mandibular relationship a more predictable task.

In this case, a 66-year-old man with a history of a total laryngectomy and radiation therapy completed in 1989

Titanium substructure, surgical grade titanium milled bars.

Figure 2

PVS matrix to determine reduction height of cylinder and bar position in relationship to the prosthetic teeth.

Figure 3

PVS matrix from another angle to evaluate cylinder height and tooth position.

Figure 4

for laryngeal squamous cell carcinoma experienced a recurrence in his retromolar trigone area in 2007 and underwent tumor excision. The surgery involved much of the body and angle of the mandible on his right side, and surgical reconstruction with an osteocutaneous microvascular fibula free flap.[3,4] Following initial healing, five mandibular osseointegrated implants were placed - four in the native mandible and one in the neo-mandible (Figure 1). The implants were placed in consultation with the reconstructive surgeon, prosthodontist and dental laboratory technician. The prosthodontic rehabilitation consisted of fabrication of a new maxillary complete denture and mandibular fixed-detachable hybrid prosthesis.

Following the surgical reconstruction, implant placement, abutment placement and soft tissue healing, the treatment of the patient was routine and included, preliminary impressions, final abutment level impressions, fabrication and try-in of a verification index to establish absolute accuracy of the final impression, maxillo-mandibular relation records, wax esthetic try-in, clinical delivery and follow-up.

Upon receipt of the accurate master cast and esthetic wax try-in, the prosthetic tooth placement was established and the laboratory proceeded with the fabrication of the framework and final acrylic resin processing.

For the substructure, the technician utilized surgical grade titanium milling bars and the appropriate screw-retained milling cylinders for the implant system specified by the prosthodontist (BTI) (Figure 2). From the wax-up on the master cast, a PVS putty matrix was fabricated to guide the technician in appropriate contour and reduction of the connecting bar and components prior to welding assembly (Figures 3 and 4). The bar stock was cut to the correct length and prepped with an abrasive rubber wheel evening on both ends (mesial and distal) to approximately a 45° angle (Figure 5). The 45° angle at the end of the stock required a little longer to build up with the weld but resulted in a stronger weld with the overlapping.

If a technician starts with the furthest cylinder on the left and work to the anterior, he or she can start on the furthest right hand cylinder, work to the anterior leaving the last two critical welds in the anterior. In this case, the welds were completed using BTI Titanium Wire and a V30 Laser Welder which required the use of an argon atmosphere to insure an oxide free, strong weld joint (BTI) (Figures 6 and 7). The parameter controls are shown on Figure 6.

Figure 5

Bar stock prepared with a 45° angle at the end. This preparation will allow overlapping of welds and help insure strength and accuracy of the substructure.

Figure 6

Available laser welding wires. It is important to note different types for differing parent metals and the importance of using the correct welding wire.

View of control panel of V3.0 laser welder. Note the parameters for this project are on the instrument view screen.

Figure 7

Occlusal view of the framework with additional material added to the right posterior to support the acrylic resin in relation to the tooth position and implant placement in the neo-mandible. Ideal placement would have not necessitated addition of additional support.

Figure 8

Facial view of framework with additional mechanical retention placed with a conical bur and aluminum oxide etching for the acrylic resin.

Figure 9

Multiple welding wires are available, however, it should be noted that the metals to be welded must possess the same properties. Metals of differing physical properties should not be joined as it will result in catastrophic weld failure. A properly prepared and heated weld should exhibit a shiny chrome-like appearance. An over or under headed joint will have a brown or blue appearance and indicates a weld that is inadequate and weak.

The procedure to keep the work piece in line is to start by tacking one corner of the two adjoining metals, rotating the piece 180° and tacking that corner, rotate back and tack the opposite side until all four corners are properly joined. A full weld can be done on one side, rotating and welding a full bead on the other. Overlapping all welds will produce a stronger joint to help prevent structural failure. This technique has consistently produced passively fitting frameworks with no detectable rock or rotation on the master cast.

On the finished framework additional stock material had to be added to the right posterior area. This was due to the placement of the implants versus actual placement of the prosthetic teeth. This extra material was required to provide optimal support of the acrylic resin and prevent material fracture (Figure 8). A conical bur was utilized to cut additional indentation in the bar stock for supplemental acrylic retention, along with etching using 50 micron aluminum oxide (Figure 9).

To prevent a gray metal showing through in the acrylic resin, the clinician requested the framework be treated with pink opaque prior to processing the acrylic resin. A light pink polymerized opaquer (GC Gradia Gum GO11, GC America) was utilized.

The prosthetic teeth were re-waxed on the framework utilizing the previously fabricated PVS matrix, festooned, screw access holes cleaned, removed from the master cast, attached to laboratory analogs, invested and processed in the technique of choice. The clinician requested characterized acrylic resin for improved esthetics and this was accomplished using a standard addition of various colored acrylic resins. The characterization was allowed to initially polymerize for about 10 minutes before packing the final base shade acrylic resin to make sure the characterization addition would not distort or move during the process utilized by the technician prior to the prescribed heat polymerized injection molding technique (Ivocap Injection System, Ivoclar Vivadent). Following the processing cycle, the prosthesis was deflasked, finished and polished in a routine manner (Figures 10-12).

Care must be taken during finishing and polishing not to modify the implant contact surface of the cylinders. A routine laboratory remount can then be accomplished to verify the previously established vertical dimension of occlusion and occlusion scheme as requested by the clinician has not been changed during the polymerization and re-waxing procedure.

When the completed prostheses was received from the laboratory, it was inspected by the clinician for accuracy, finish and polish. The mandibular healing caps were removed and the fixed-detachable prosthesis put to place, checked for passive fit and the retaining screws tightened to the appropriate torque value as required by the implant manufacturer.

The maxillary complete denture was tried in, checked for soft tissue contact with pressure indicator paste and a remount record made for a clinical remount

Occlusal view of finished prosthesis and screw access holes.

Figure 10

Left side view of finished prosthesis.

Figure 11

Right side view of finished prosthesis (defect side).

Figure 12

(Figures 13-16). The occlusion is adjusted if necessary at the remount, any areas of adjustment are re-polished and a final seating radiograph is taken for baseline reference at subsequent appointments. The patient was given oral hygiene instruction, the screw access holes were closed and the patient dismissed until the scheduled recall appointment.

A patient with a complex mandibular defect can be restored today utilizing advanced surgical, prosthodontic and dental laboratory technology to a level that was not imagined several years ago. Most of the patients treated with the techniques described in this article do exceptionally well with a predictable longevity and prognosis for their prostheses.

The use of laser welded titanium prosthesis is a significant advancement in technology compared to the cost, time and efforts of a lost wax or casting technique previously utilized for many of the implant frameworks previously restored.

Personal experience restoring dozens of full arch implant patients with this technique during the last five years has shown a significant improvement in the accuracy and passivity of fit from previously cast frameworks. This is likely due to the fact that the framework is directly assembled on the master cast compared to waxing, sprueing, investing and casting where there is a significant increase in the areas where expansion or contraction and distortion factors play a major role. To date no frameworks have required significant repair.

As always stated but not often practiced, communication within the dental team is critical for optimal patient treatment. The technician must be involved with patient treatment at an early stage and understand the limitations of surgery and prosthodontics. Likewise, the surgeon should have knowledge of prosthodontic

Intraoral view of abutments and healing caps.

Figure 13

Intraoral view of mandibular prosthesis in place.

Figure 14

Both maxillary and mandibular prostheses in place with the patient in maximum intercuspation.

Figure 15

Finished smile with completed prostheses.

Figure 16

and laboratory capabilities in the initial planning phase. The prosthodontic clinician must be familiar with both the surgery and laboratory phases also. Accurate planning, impressions, accuracy verification and sound clinical and laboratory techniques will result in the most optimal treatment and outcome for the patient.

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About the Authors:

BOB SCHNEIDER is a professor at the University of Iowa Hospital and Clinics, Institute of Hospital Dentistry, Division of Maxillofacial Prosthodontics, where he has a full-time, private practice. He has published extensively in the peer-reviewed prosthodontic literature and is very active in many prosthodontic and dental laboratory organizations. Additionally he lectures internationally about many subjects addressing the clinical and laboratory phases of fixed, removable and implant prosthodontics.

DANNY ROBERTS has 25 years experience. He started his dental laboratory career in 1983 and successfully completed his certification in 1989. He owns and operates Hawkeye Dental Studio in Cedar Rapids, Iowa, and specializes in esthetic removable, laser assembled titanium bars and attachments for removable partial denture/fixed partial denture combination cases.

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1hr

CPD Questions

1. The use of a titanium laser welded framework was not chosen because of strength.
True ☐ **False** ☐

2. The acrylic resin injection polymerized type prosthesis was selected for the relative ease of fabrication, less complicated future repair when indicated compared to a porcelain-fused-to-metal restoration and the ability to simulate the lost gingival and appropriate tooth form.
True ☐ **False** ☐

3. For the substructure, the technician utilized surgical grade titanium milling bars and the appropriate screw-retained milling cylinders for the implant system specified by the prosthodontist.
True ☐ **False** ☐

4. A PVS putty matrix was fabricated to guide the technician in appropriate contour and reduction of the connecting bar and components after welding assembly.
True ☐ **False** ☐

5. The 45º angle at the end of the stock required a little longer to build up with the weld but resulted in a stronger weld with the overlapping.
True ☐ **False** ☐

6. If a technician ends with the furthest cylinder on the left and works to the anterior, he or she can start on the furthest right hand cylinder, work to the anterior leaving the last two critical welds in the anterior
True ☐ **False** ☐

7. Metals to be welded must possess the same properties.
True ☐ **False** ☐

8. A properly prepared and heated weld should exhibit a shiny chrome-like appearance.
True ☐ **False** ☐

9. An over or under-heated joint will have a pink appearance and indicates a weld that is inadequate and weak.
True ☐ **False** ☐

10. Overlapping all welds will produce a stronger joint to help prevent structural failure.
True ☐ **False** ☐

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I certify that the answers hereby submitted for these questions are completely and wholly my own work and have not been copied in part, or in whole, or otherwise plagiarised from the work of others.

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Date