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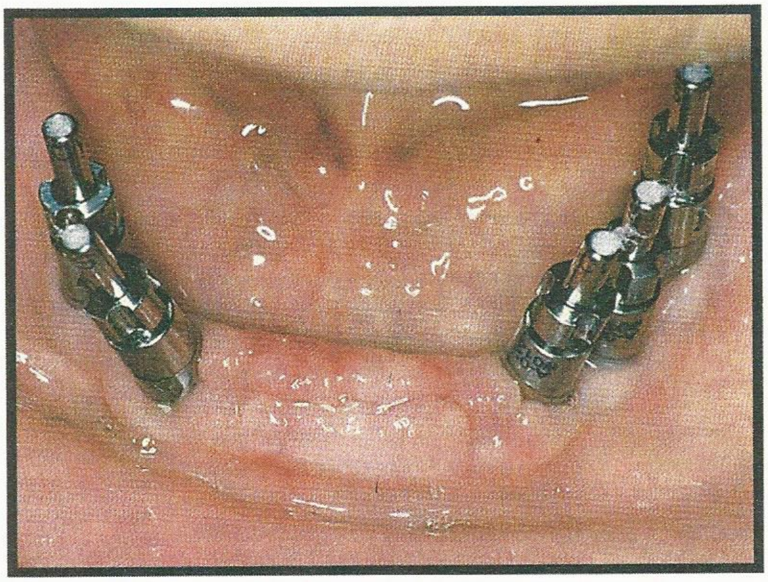

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THE USE OF LASER-WELDED TITANIUM FRAMEWORK TECHNOLOGY: A CASE REPORT FOR THE TOTALLY EDENTULOUS PATIENT

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KEY WORDS

Laser-welded titanium
Superstructure
Direct (open) impression

Laser-welded technology has become a viable alternative to the conventional lost wax-casting technique in the field of implant dentistry. Studies have demonstrated the predictable nature of laser-welded titanium frameworks for endosseous implants in the partial and totally edentulous patient. A standardized impression and fabrication procedure is required for an accurate and predictable superstructure. More long-term studies are needed for more widespread acceptance and usage by dental practitioners.

INTRODUCTION

The field of implant dentistry has used bar superstructures to hold retentive features for removable implant-supported overdentures for many years.[1–3] These superstructures offer additional support and retention for the oral prosthesis by means of clips, balls, and their unique design. Laser-welded technology in implant dentistry is not new, but improvements in lasers and technical expertise have made it a predictable alternative to cast-metal technology.[4,5]

The properties of titanium offer many advantages for its use in bar superstructures, including corrosion resistance, biocompatibility, light weight, and cost. The greatest technical advantage is that thermal expansion and contraction is limited because of the precision of laser energy, thereby allowing a passive fit of the superstructure.[6,7] Laser energy produces little to no heat, thereby avoiding the pitfalls of thermal expansion and distortion of the casting process. The weakest link for bar superstructures for alloy varieties is in the incorporation of soldering in dentistry. Solder joints are prone to corrosive processes and separation, leading to failure of the dental prosthesis. The yield strengths of laser-welded connections are approximately 2½ times stronger than soldered connections. Finally, the cost of fabricating a laser-welded titanium bar or repairing a nonpassive connection is easy and more affordable than its conventional gold-alloy counterpart.

Laser-welded titanium superstructure bars for the retention of removable-implant overdentures are composed of premachined titanium cylinders screwed into

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conventional transmucosal abutments and bars of titanium cut in various lengths. The same technology can be used to incorporate specific attachments to the superstructure to gain additional retention for the final prosthesis. The female housings with inserts are processed in the acrylic of the final prosthesis.

In previous years, scientific evidence was established concerning the precision of framework fit of titanium superstructures.[8–10] The studies concluded that no significant difference in marginal fit of titanium frameworks vs cast-alloy frameworks was apparent when viewed radiographically, clinically, or by a photogrammetric technique. However, fewer loose screws were reported 3 weeks postplacement in the titanium framework group, suggesting that the titanium framework group may have a more passive fit. It is well proven that loose screws are associated with higher fracture rates of component parts, additional appointments, eventual implant loss, and case failure. In addition, a more passive superstructure results in a reduced need for soldering, welding, or refabricating a titanium or cast-alloy frameworks.

Bergendal and Palmquist[11,12] reported that titanium frameworks compared favorably with cast-alloy frameworks. They stated that no statistical significance was found in implant loss, framework fractures, component fit, or margin bone loss. However, complications that were present with the titanium groups included gingival hyperplasia and fracture of resin prosthetic teeth. The edentulous maxilla demonstrated a higher rate of implant loss compared with the mandible in well-documented findings in the literature.[13–15] A 5-year study by O¨rtorp et al[16] showed that laser-welded titanium frameworks supported by implants in the edentulous mandible demonstrated results similar to those of cast-alloy frameworks. There was no difference in bone loss, implant failure, or implant component parts. However, if a fracture did occur in the titanium framework group, it was at the distal cantilever junction. In addition, the authors suggested that additional relines or fabrication of a new opposing removable prosthesis may be needed. The study concluded that the choice of material for the framework did not significantly affect the clinical outcome of implant treatment in the edentulous mandible or maxilla.

Methods

Clinical stage

The prosthetic stage begins 6 weeks after second-stage uncovery surgery. Removal of the titanium healing collars and measurements of the gingival sulcus are performed to allow for the selection of transmucosal abutments. These abutments are placed, and after a confirming radiograph the retaining screws are torqued down as suggested by the specific implant manufacturer's recommendation (Figure 1). The premachined nonhexed titanium cylinders are screwed into the abutments, and cotton pellets are placed into the long access-screw holes (Figure 2). The titanium premachined cylinders will become part of the final bar superstructure. A custom tray is fabricated for an open (direct) technique, and a polyvinyl siloxane impression is taken (Figure 3). The titanium cylinders are secured within the impression tray and sent to the laboratory for the fabrication of a master model (Figure 4). The healing caps are placed onto the titanium abutments with a hex tool.

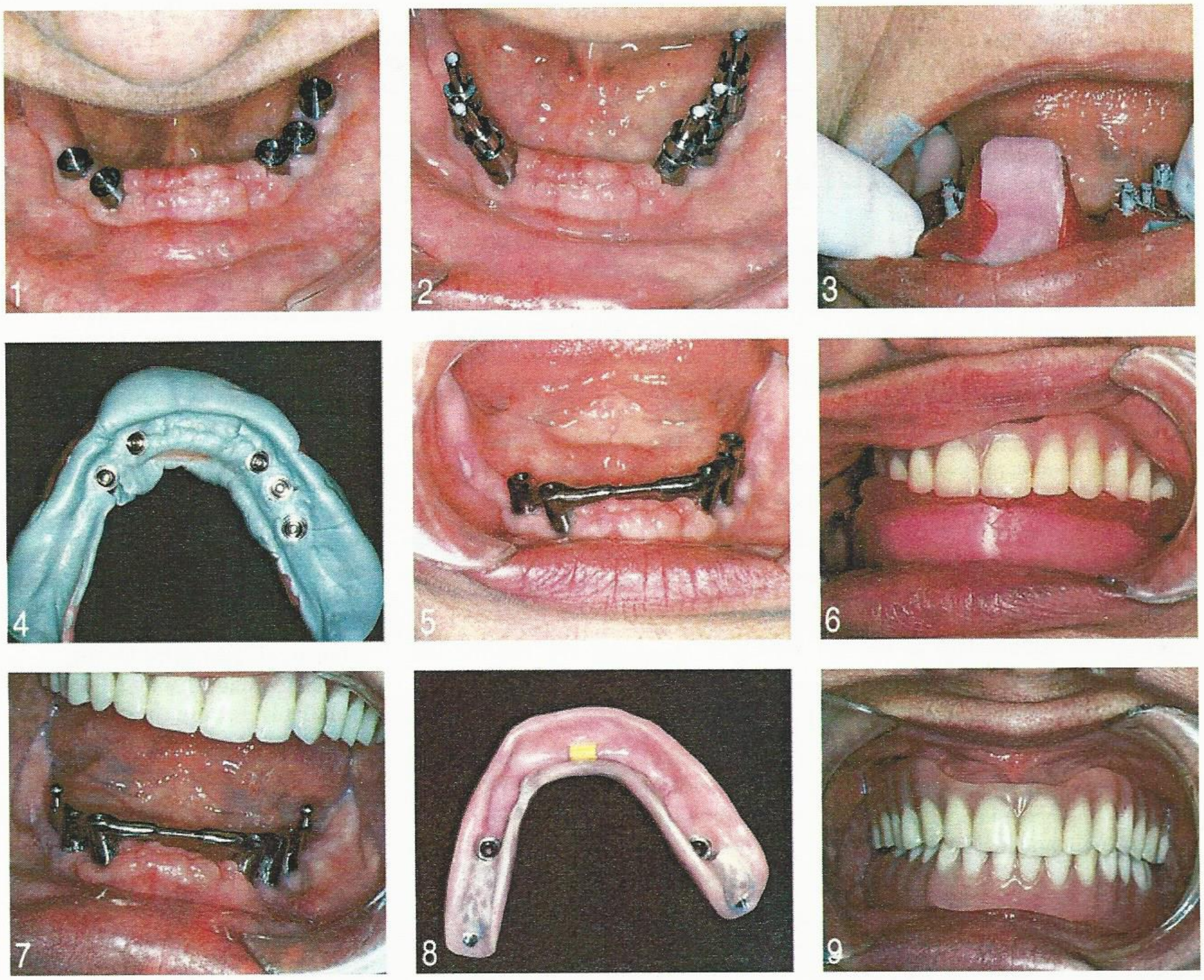
Laboratory stage

The implant-abutment analogue is screwed into the titanium cylinders found within the impression material, followed by the fabrication of a master cast. The technician selects premeasured titanium bars and uses an alpha laser to spot weld them to the titanium cylinders. The alpha laser can predictably spot weld titanium joints to a maximum depth of 4 mm. The long impression screws of the titanium cylinders are reduced in height and are polished. The technician incorporates a retentive clip into the trial base, and a bite rim is fabricated for the dentist to establish a maxillary-mandibular relationship. After confirmation of passivity of the laser-welded bar intraorally, the laboratory will complete the process of attachment placement, denture tooth set-up, and processing. ***(See correction below)***

Clinical Stage

The titanium healing caps are removed from the transmucosal abutments and replaced with the titanium laser-welded bar (Figure 5). A panoramic radiograph is taken with 1 screw placed in a distal implant position. The passivity of the bar is confirmed, and a maxillary-mandibular relationship is taken (Figure 6). If the laser-welded bar is not passive, the bar is sectioned and luted together with resin or duralay. The laboratory technician will drill out the nonpassive implant from the master model, repour it in stone, and laser weld the new corrected orientation. A denture tooth try-in confirms vertical di-

** All appliances were fabricated with BTI fiber optic lasers.



FIGURES 1–9. FIGURES 1–4 (clinical stage). FIGURE 1. Intraoperative view after placement of titanium manufacturer's abutments. FIGURE 2. Occlusal view after insertion of titanium transfer coping with long fixation screws (cotton placed into screw holes). FIGURE 3. Custom tray (open). FIGURE 4. Internal view of titanium transfer copings fixated in polyvinyl siloxane impression. FIGURES 5–9 (laboratory stage). FIGURE 5. Laser-welded titanium superstructure bar without attachments. FIGURE 6. Frontal view of maxillary-mandibular relationship. FIGURE 7. Frontal view of final laser-welded titanium with distal ball attachments. FIGURE 8. Tissue side of the mandibular implant-supported overdenture with O-rings and Hader clip. FIGURE 9. Frontal view of the final complete maxillary denture and mandibular implant-supported overdenture (centric relation).

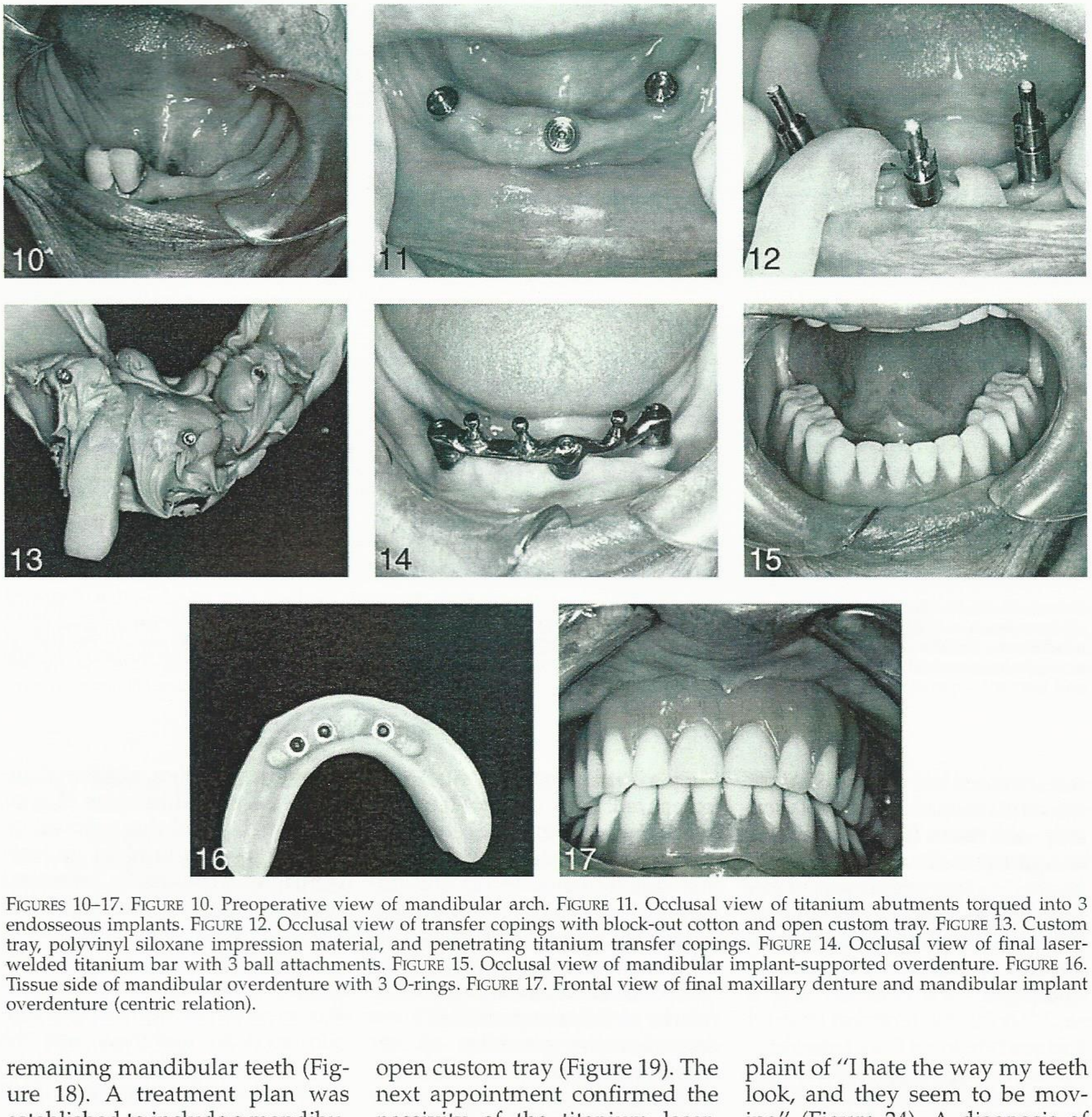
mension, occlusion, esthetics, and phonetics. The final prosthetic visit includes placement of the titanium bar and the processed overdenture with its retentive housings, O-rings, and clips (Figures 7 through 9).

Case 1

A 68-year-old woman presented for prosthetic treatment of the mandible. Her 2 remaining teeth had a poor prognosis, and a definitive treatment plan was established (Figure 10). A removable implant-retained overdenture (RP-5) supported by 3 endosseous implants and a complete denture was to be performed.[17] The prosthetic stage was initiated 3 months postsurgery with the attachment of transmucosal abutments (Figure 11). A custom tray (open) with polyvinyl siloxane impression material was used to capture the premachined titanium cylinders screwed to the abutments (Figures 12 and 13). A bar try-in, maxillary-mandibular registration, and denture tooth setup were performed (Figure 14). This was followed by final placement of the mandibular prosthesis (Figures 15 through 17).

Case 2

A 65-year-old man presented to the office with a concern about 2

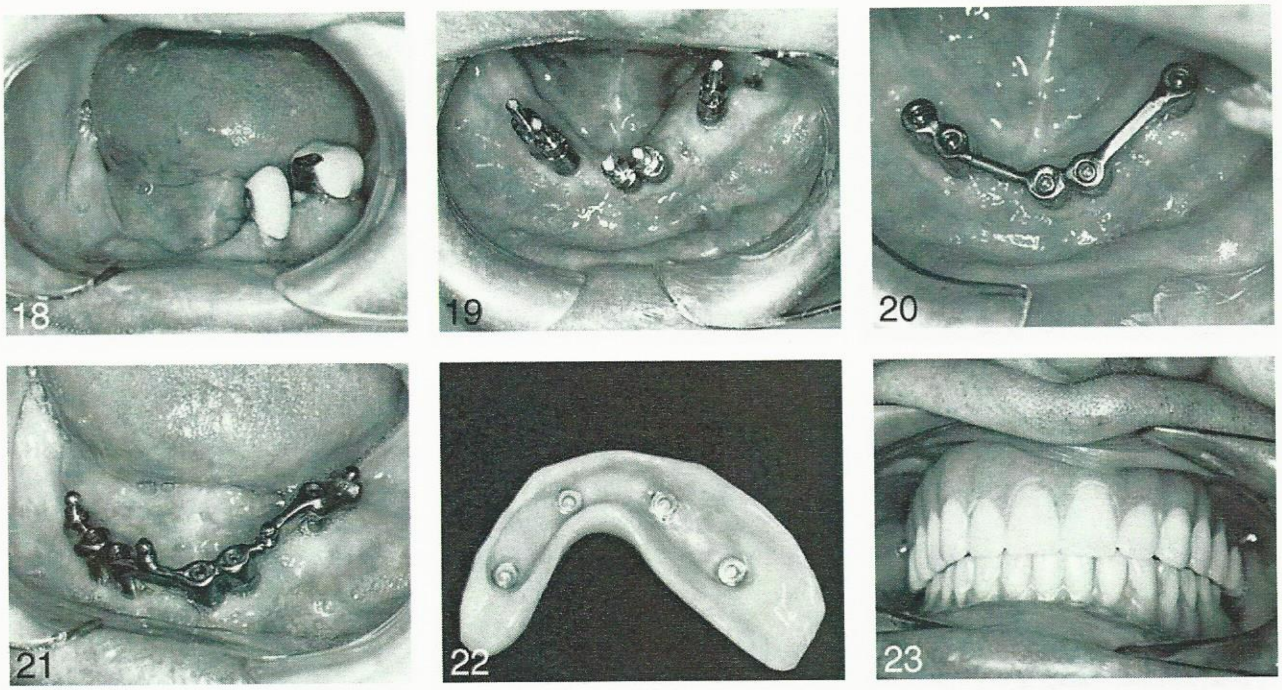


FIGURES 10–17. FIGURE 10. Preoperative view of mandibular arch. FIGURE 11. Occlusal view of titanium abutments torqued into 3 endosseous implants. FIGURE 12. Occlusal view of transfer copings with block-out cotton and open custom tray. FIGURE 13. Custom tray, polyvinyl siloxane impression material, and penetrating titanium transfer copings. FIGURE 14. Occlusal view of final laser-welded titanium bar with 3 ball attachments. FIGURE 15. Occlusal view of mandibular implant-supported overdenture. FIGURE 16. Tissue side of mandibular overdenture with 3 O-rings. FIGURE 17. Frontal view of final maxillary denture and mandibular implant overdenture (centric relation).

remaining mandibular teeth (Figure 18). A treatment plan was established to include a mandibular implant-supported overdenture (RP-4) and a complete maxillary denture.[18] His prosthetic stage was initiated 3 months postextraction and implant placement. The impression stage included the placement of titanium transmucosal abutments, the placement of premachined nonhexed titanium cylinders, and the utilization of an open custom tray (Figure 19). The next appointment confirmed the passivity of the titanium laser-welded bar and the establishment of a maxillary-mandibular relationship (Figure 20). A final bar and attachments were placed, followed by the definitive prosthesis (Figures 21 through 23).

Case 3

A 60-year-old woman presented to the office with a chief complaint of "I hate the way my teeth look, and they seem to be moving" (Figure 24). A diagnosis of chronic apical periodontitis was made, and a treatment plan of 6 endosseous implants and a removable maxillary implant overdenture (RP-5) was established.[19] A polyvinyl siloxane impression was taken with a custom tray of the premachined nonhexed titanium cylinders screwed into the titanium transmucosal abutments (Figures 25 and 26). A titanium



Figures 18–23. Figure 18. Intraoperative view of mandibular arch (presurgical). Figure 19. Occlusal view after insertion of tapered abutments and AOII titanium transfer copings (cotton in long screw posts). Figure 20. Laser-welded titanium bar without attachments. Figure 21. Complete laser-welded titanium superstructure with 4 ball attachments. Figure 22. Tissue side of mandibular overdenture with 4 nylon cap attachments in metal housings. Figure 23. Frontal view of complete maxillary denture and implant-supported mandibular overdenture.

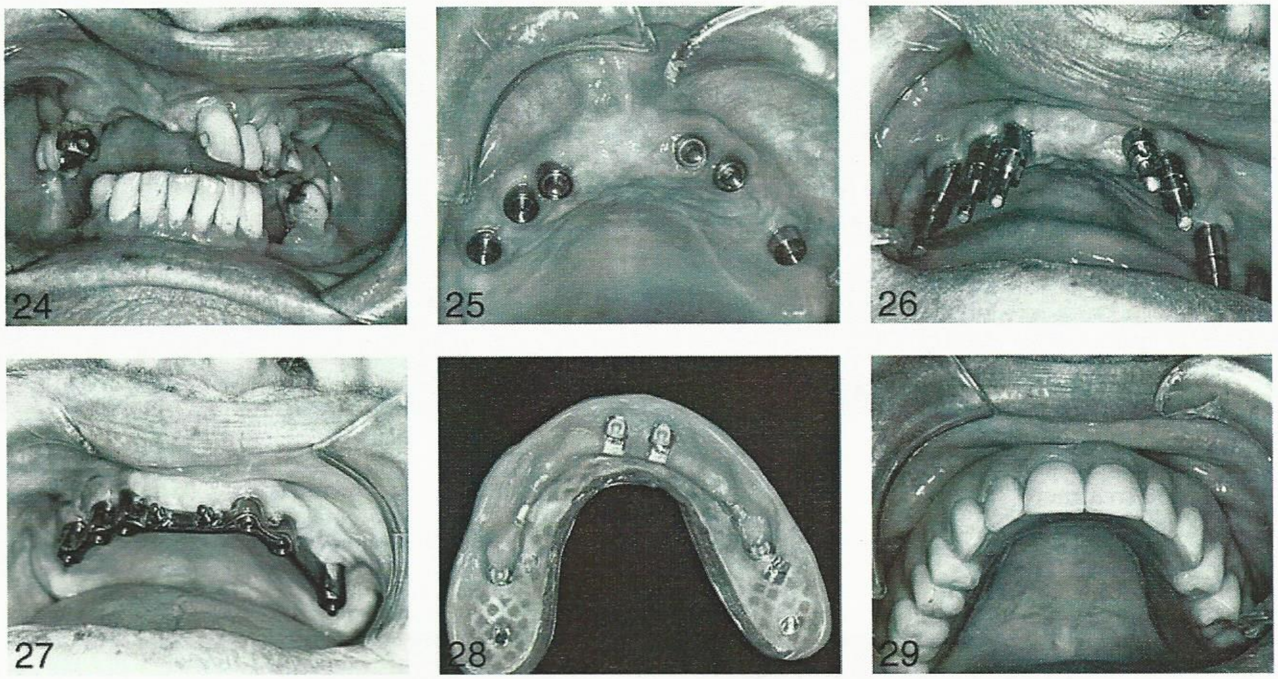
laser-welded bar was tried in, and a maxillary-mandibular relationship was taken (Figure 27). After a denture tooth set-up was tried in, the final prosthesis was placed and the occlusion was adjusted based on implant protective occlusion principles (Figures 28 and 29).[20,21]

Discussion

A critical issue in long-term success of endosseous implants is the ability to reduce stress to the crestal bone.[22] Research has demonstrated that laser-welded technology shows no significant difference in superstructure fit or implant loss when compared with conventional gold-alloy frameworks. Studies have demonstrated that thermal distortion of laser-welded frameworks shows no statistical difference compared with cast-gold frameworks. However, the standard deviation in distortion is greater for cast frameworks, so the potential of nonpassive frameworks exists on a more frequent basis. The lack of loose screws associated with laser-welded frameworks at follow-up clinical visits indicates the passivity of bar superstructures. It is well documented that loose screws are precursors to prosthetic component part fractures, bone loss, and implant failure.[23]

Research has successfully exhibited that laser-welded superstructures can be used in the edentulous maxilla and mandible. The complication rate, including bone loss, superstructure fracture, and implant loss, statistically parallels cast gold-alloy superstructures. As a result, it is recommended that additional implants be placed in areas of poor bone quality and that strict attention be paid to implant occlusal principles. The cases presented in this study were treatment planned with bone quality as a significant factor. The incorporation of additional implants and bar superstructures without cantilevers was designed into the maxillary case.[24,25]

Research has indicated that some complications of laser-welded titanium frameworks exist, with the most common being prosthetic veneer fracture from the superstructure. In recent years, the development of low-fusing porcelains and improved technical expertise has demonstrated that sufficient bond strength can be achieved. However, this complication is moot in the application of laser-welded tech-



FIGURES 24–29. FIGURE 24. Intraoral view before maxillary extractions and implant surgery. FIGURE 25. Occlusal view of titanium abutments fixated to endosseous implants. FIGURE 26. Frontal-occlusal view of AOII titanium transfer coping and long fixation screws with cotton pellets inserted into tapered abutments. FIGURE 27. Final laser-welded titanium bar with 4 ball attachments. FIGURE 28. Tissue side of maxillary implant-supported overdenture with 4 strategy attachments. FIGURE 29. Occlusal view of complete maxillary implant-supported overdenture.

nology in removable implant-supported bar overdentures. Most other reported complications, such as gingival hyperplasia, implant loss, and superstructure fracture, are not unique to titanium frameworks.

A disciplined, predictable approach to the fabrication of laser-welded titanium super structures is essential. The utilization of panoramic radiographs to confirm correct transmucosal abutment placement followed by the stretching of the fixation screw with a calibrated torque wrench is critical. The laser-welded titanium bar must be evaluated clinically and radiographically with 1 screw tightened into a distal implant site. The retentive features must be placed within the confines of interocclusal clearance and based on angulation of force. The correct maxillary-mandibular relationship should be established and confirmed with a try-in of the denture tooth set-up. After confirmation of vertical dimension, occlusion, and esthetics, the complete implant overdenture can be processed with the appropriate retentive housings and attachments.

The cases included in this study have demonstrated the utilization of laser-welded bar technology for the edentulous maxilla and mandible. In case 1, an implant and soft tissue–supported removable overdenture (RP-5) with 6 implants was demonstrated. Because of poor bone quality, a removable prosthesis was selected with additional implants placed, without cantilevers, and with low-profile attachments incorporated into the bar. The advantage of using a removable prosthesis is the ability for removal in instances of nocturnal bruxism. In case 2, an implant-supported removable over denture (RP-4) with 4 O-ring and nylon attachments was performed. The prosthesis was completely implant supported with distal cantilevers placed at 1.5× the A-P spread, 0° posterior teeth, and a lingualized bilateral balanced occlusion.[26] Case 3 exhibited a soft tissue and implant-supported removable overdenture (RP-5). The treatment plan included 3 endosseous implants placed in good bone quality and a titanium superstructure without cantilevers and with 3 O-ring retentive attachments. This prosthesis is excellent when retention is the major objective to treatment, whereas support and stability are less paramount. A marked reduction in tissue ulceration is accomplished with this type of removable prosthesis.

Conclusion

Laser-welded titanium technology in the field of implant dentistry has evolved to a stage of predictable results. Studies have proven that minimal complications are associated with this technology when compared with conventional cast-alloy frameworks. The use of bar superstructures with titanium bars can be successful in maxillary and mandibular edentulous arches. These cases demonstrate that a long-term good prognosis can be achieved when organized treatment plans are used. Although laser-welded titanium frameworks have improved significantly over recent years, long-term studies are required before widespread acceptance and use by dental practitioners. However, the current body of research on this subject is certainly promising.

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