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CLINICAL CASE

Immediate Load Fiber Reinforced Hybrid Implant Prosthetics

Maurizio Grande, Gregori M Kurtzman, Carlo Baroncini

ABSTRACT

Immediate loading of implants placed at time of implant placement requires both adequate insertion torque and rigidity of the provisional prosthesis to allow placement of a restoration during the healing phase. Screw-retained provisional prosthesis allows better stability during the healing phase than cemented prosthetics and prevents cement seal breakage that could transfer greater loads to individual fixtures during this critical phase. Various methods of increasing the rigidity of the provisional material have been utilized and reported in the literature. A case describing the use of a woven fiber reinforcement ribbon will illustrate how to use this material and the benefits over either metal wire reinforcement or utilization of a cast frame.

Keywords: Immediate load, Fiber reinforcement, Provisional implant prosthesis.

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Conflict of interest: None declared

INTRODUCTION

The primary goal in immediate loading of implant prosthetics when multiple adjacent implant fixtures are being placed is rigid immediate cross arch stabilization of the provisional prosthesis.[1,2] Utilization of an immediate provisional fixed prosthesis requires that the prosthesis be rigid enough that function during the healing period does not transmit lateral loading to the implant fixtures.[1,3,4] The challenge clinically is both cost containment for the provisional prosthesis and the ability of the laboratory to quickly return the prosthesis within 24 hours of implant placement.[2,5]

Rigidity can be incorporated into the provisional prosthesis either by incorporation of prefabricated strengthener (i.e. metallic wire or fiber) or with a custom cast structure.[6] Both of these options have costs associated with them, with cast structures being higher cost due to the additional laboratory time required to fabricate it. Additionally, fabrication of a custom cast strengthener is time consuming and may not be practical when a 24 hours turnaround time on the provisional is required. Another option is laser welding of stock sections of titanium bar between the titanium provisional heads. But, the majority of laboratories do not have a laser welder present and subcontract out when laser welding is required, which will not be feasible with the rapid turn around time required for the provisional.

Incorporation of prefabricated strengtheners becomes the logical option both from a cost standpoint but also allowing utilization within the desired time frame. The materials available include; stainless steel wire and fiber reinforcement. Although, stainless steel wire has been a popular strengthener in the past due to its low cost, there are potential negative consequences to its use in a provisional prosthesis. As the resin composing the prosthesis does not bond or adhere chemically to the wire under load it is possible to have slippage of the wire from the resin. Because the wire does not bond to the resin and is therefore not an integral part of the resin structure, it acts as a stress concentrator and therefore promotes crack initiation and propagation.[7] This leads to increasing micromovement within the prosthesis materials and cracks can develop in the resin leading to failure of the prosthesis. Once cracks develop within the prosthesis 'uneven' loading occurs on the individual fixtures and failure can result in some or all of the fixtures during the critical integration period.

Fiber reinforcement has become increasingly used due to its superior properties compared to stainless steel wire and its ease of use.[7-10] Fibers are available in various fiber architectural design configurations. Because the unidirectional fibers are by definition oriented only in one direction, they offer no performance improvement to the resin in any direction other than directly perpendicular to the unidirectional fibers. The leno-weaved and triaxial braided ultra high-molecular weight polyethylene ribbons used in this case (ribbond) were selected because they exhibit the most optimum energy absorbing and stress distributing characteristics of any of the fiber systems available in the dental market place.[11-13] They serve as crack stoppers and toughening agents. These fiber systems inhibit, stop and redirect cracks.[14] Minor cracks that do occur are constrained within the areas of the triaxially braided and leno-weaved fibers which then restrict their growth to small regions. Once a crack reaches the plane of the fibrous reinforcement, its forward path is blunted and it propagates along the weaker fiber-resin interface causing it to change directions. This crack redirecting process allows these two fiber designs to avoid catastrophic failure and movement of the parts of the resin prosthesis.[15] The crack deflection and redirection, and

toughening mechanisms of these fiber systems in dental resin and composite resin provisional restorations prevents major crack propagation and this therefore becomes an effective method for the reinforcement of immediately loaded provisional prostheses.[16] These immediately loaded provisional implant bridges can easily be modified in the dental clinic, if there is the need to add an additional implant or if a failed implant must be removed. These fibers can easily be cut or additional fibers of the same kind can easily be incorporated within the bridge using the standard equipment and materials found in every dental clinic. Linear fibers do not offer the same rigidity as woven materials and may just serve to keep the prosthesis from completely separating should overload occur.[17]

Cemented *vs* Screw Retained Provisional Prosthesis

Two options exist for fabrication of the immediate provisional prosthesis, cemented or a screw retained approach. As the goal of immediate implant provisionalization is to maintain rigidity during the critical integration period, one must place a provisional that remains attached to the implants.[2,8] A cemented provisional has the potential for the cement seal to break between one of the units during function. Once the a unit in the prosthesis is no longer attached to the prosthesis, loading is transmitted to a greater degree to the uncemented unit and bone loss and increasing mobility results with loss of that unit. Frequently this does not come to the patients attention until periodontal issues have occurred on the fixture, so they are unable to notify the practitioner until it is too late. All practitioners have experienced conventional bridges on natural teeth that present with only one abutment no longer connected to the bridge and the challenges this causes in reluting the bridge.

Screw-retained bridges permit the provisional to be 'bolted' to all the fixtures. This decreases the potential for loosening on any of the fixtures and allows the practitioner to fixate the prosthesis to the implants with a set torque on the fixation screws.

CASE REPORT

An edentulous female patient presented indicating a long history of wearing full maxillary and mandibular removable prosthesis (Figs 1 and 2). The patient expressed a desire for fixed prosthesis in lower arch and after examination was treatment planned for implant-retained mandibular-fixed prosthesis and a conventional maxillary denture. The initial step involved fabricating a wax setup for a full upper and lower removable prosthesis ensuring the teeth were positioned for esthetics and phonetics (Fig. 3).

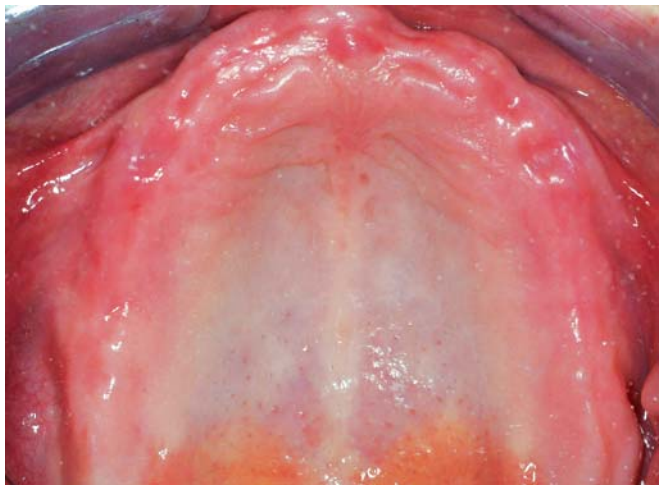

Fig. 1: Maxillary edentulous arch pretreatment

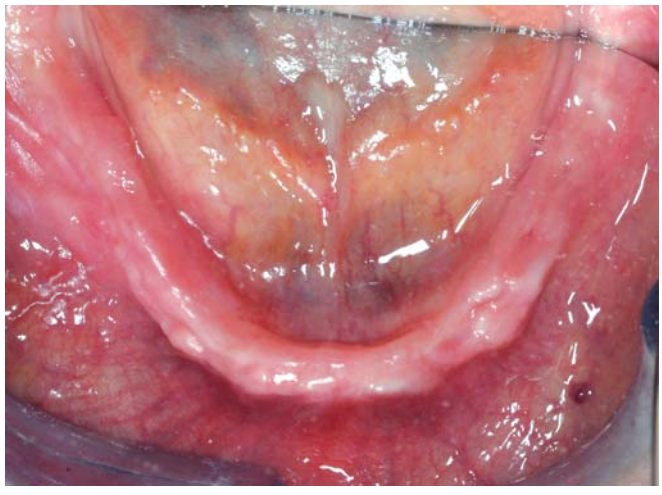

Fig. 2: Mandibular edentulous arch pretreatment

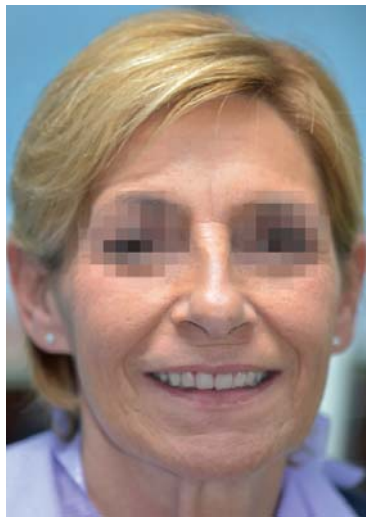

Fig. 3: Try-in of wax setup of a maxillary and mandibular full arch removable prosthesis

The wax setup dentures were then placed into the vertysystem (Vicenza, Italy) creating a mold of the setup. Into this a clear self-cure acrylic (Orthojet, Lang Dental,

Fig. 4: Radiographic markers have been placed into the clear replica of the maxillary full arch removable prostheses

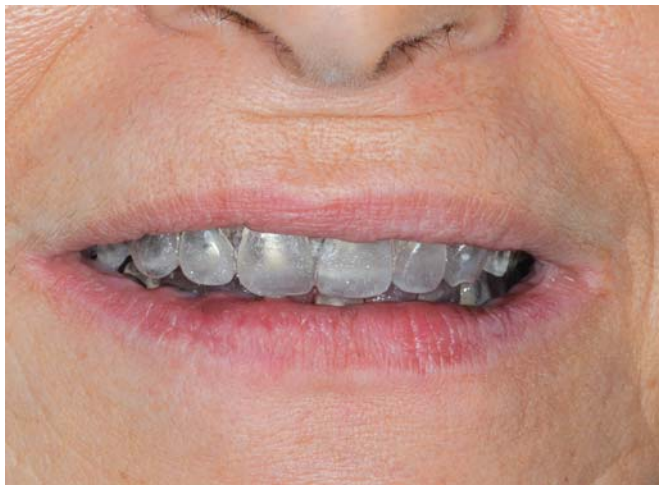

Fig. 6: The wax setup has been replicated in clear acrylic and tried in to verify occlusion

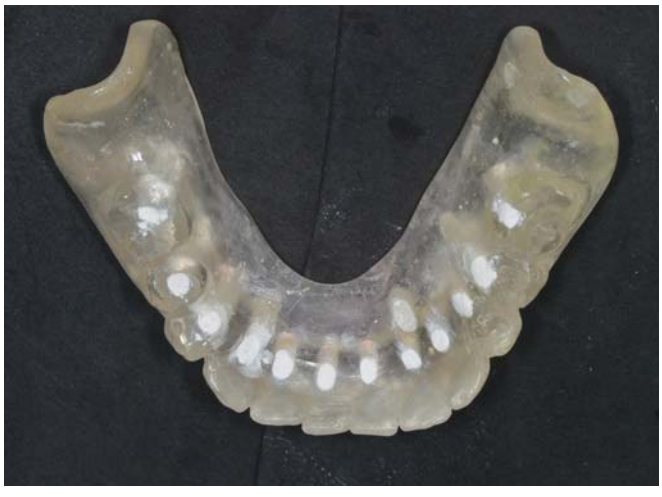

Fig. 5: Radiographic markers have been placed into the clear replica of the mandibular full arch removable prostheses

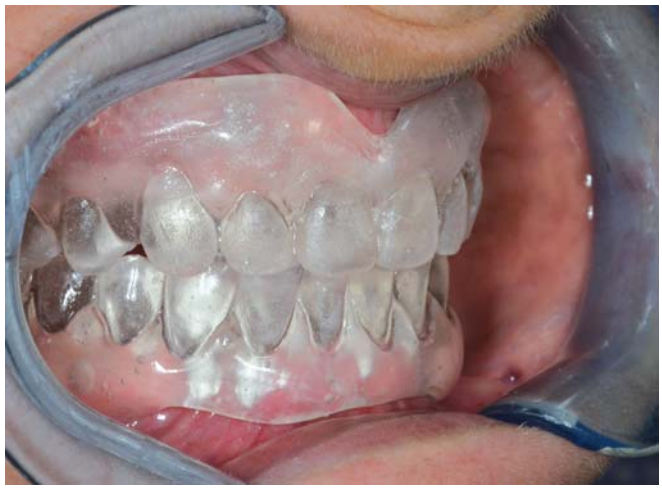

Fig. 7: Clear replica of the full maxillary and mandibular removable prosthetics with radiographic markers present

Wheeling IL, USA) was mixed and poured to create a clear replica of the wax setup. Upon setting any flash was removed from the flanges with an acrylic bur in a slow speed handpiece. Utilizing a round bur markers were made at each tooth site on the clear replica. These were then filled with a zinc oxide provisional cement (Coltosol, Coltène/Whaledent AG, Altstätten, Switzerland) creating a CBCT (cone beam CT) stent with radiographic markers (Figs 4 and 5). The radiographic stents were tried in and verified that they duplicated the esthetics and phonetics of the previously developed wax setup (Figs 6 and 7). A CBCT scan was performed with the radiographic stents intraorally using the Galileos unit (Sirona, Long Island City, NY, USA) to determine where the implants could be positioned with relation to anatomical structures and available bone (Figs 8 and 9).

Based on the CBCT scan it was decided to place implants at the following positions in the mandibular arch; left second premolar, left canine, left central incisor, right central incisor, right canine and right first molar. The scan determined that implants of 4.0 mm diameter would fit within the buccal-lingual cortical plates at each site and lengths would vary from 10.5 mm in the molar site, premolar and canine sites at 12 and 15 mm at the central incisor positions. It was decided to use BioHorizons implants (Birmingham, AL, USA) with an internal connection a parallel walled threaded endosseous fixture for this case.

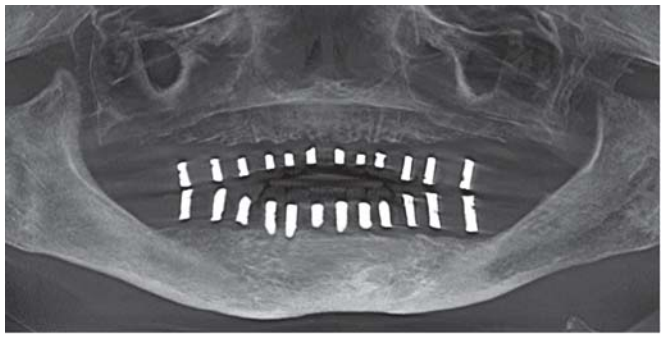

Fig. 8: Panoramic view of the CBCT scan with clear replicas of the full maxillary and mandibular stents with radiographic markers

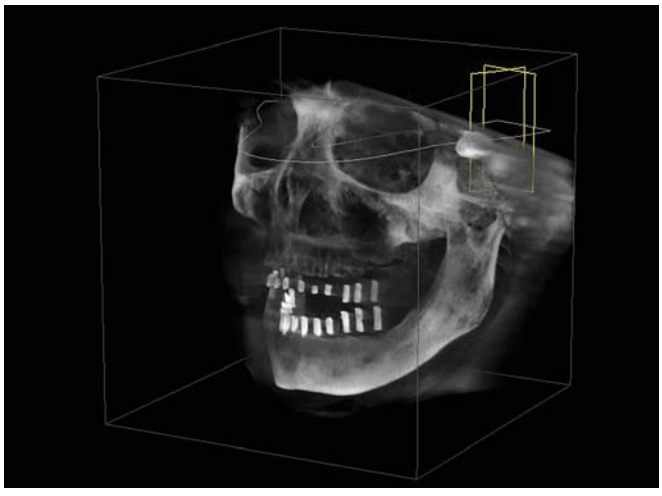

Fig. 9: 3D rendition of the CBCT scan with clear replicas of the full maxillary and mandibular stents with radiographic markers

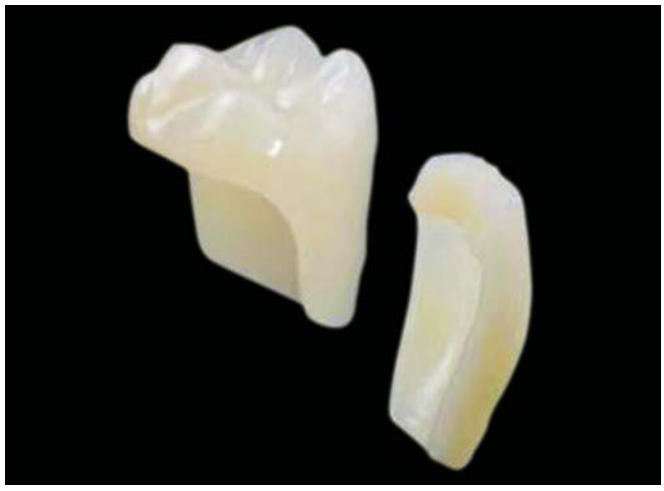

Fig. 12: Visio.lign teeth demonstrating the shell form with missing lingual to be used in implant prosthetics

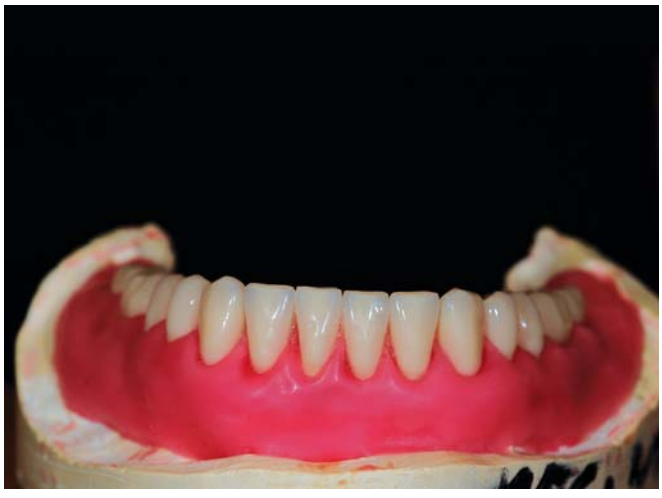

Fig. 10: Denture teeth set in wax on the mandibular arch facial view

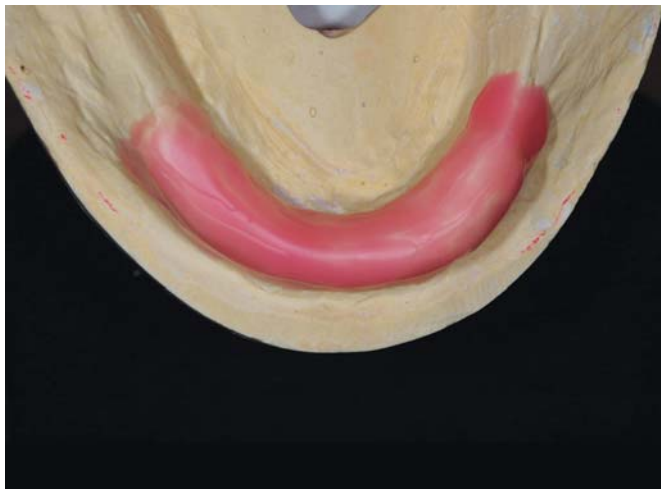

Fig. 13: Area where implants will be placed is blocked out on the preliminary cast with wax to create a spacer

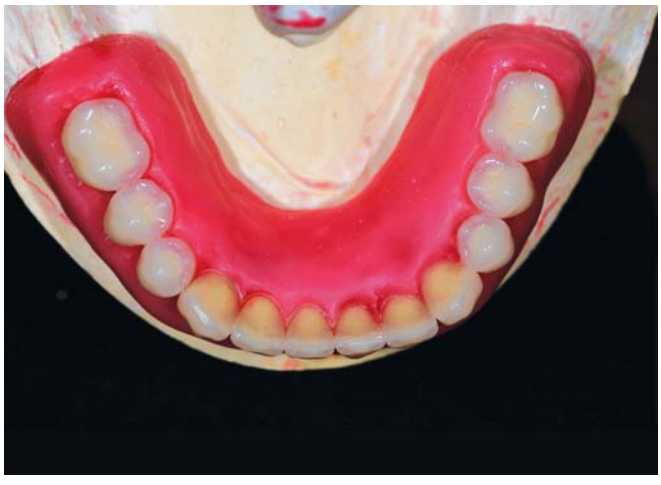

Fig. 11: Denture teeth set in wax on the mandibular arch occlusal view

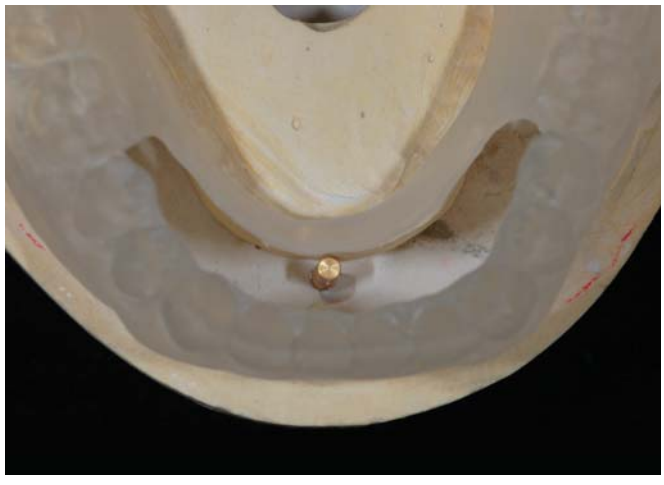

Fig. 14: Replica of the lower denture in clear acrylic is relieved, where the implants will be placed creating a window on the occlusal to be used as an open tray

A final setup of denture teeth in the mandibular arch was fabricated using visio.lign composite resin denture teeth (Bredent, Senden, Germany) terminating in the 1st molars bilaterally (Figs 10 and 11). The visio.lign teeth are specifically designed for implant prosthetics with the tooth in a shell form with each tooth consisting of a facial/buccal and incisal/occlusal with no lingual structure present conserving time needed to core the tooth to fit over the

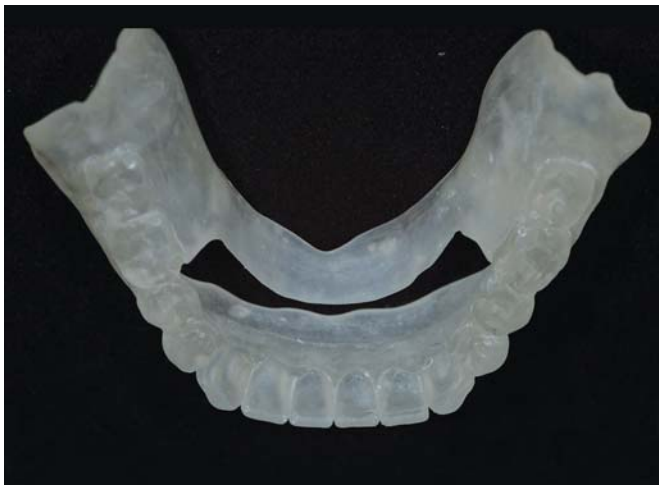

Fig. 15: Replica of the lower denture in clear acrylic is relieved, where the implants will be placed creating a window on the occlusal to be used as an open tray

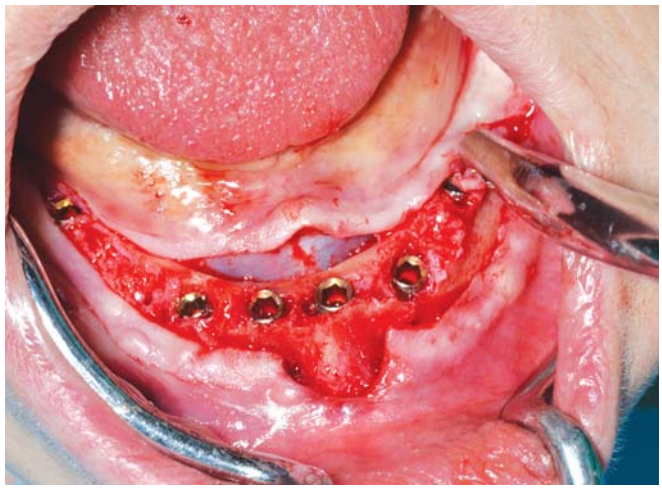

Fig. 17: Implants have been placed in the mandibular arch using an open flap technique

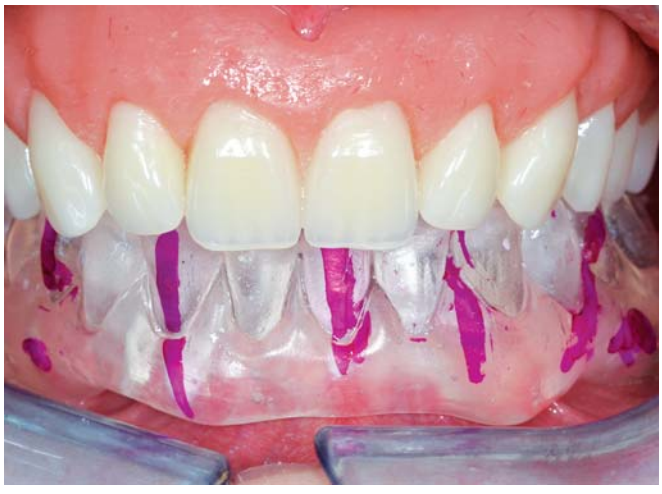

Fig. 16: Surgical stent created from the initial clear radiographic stent with marks indicating, where implant positions have been selected

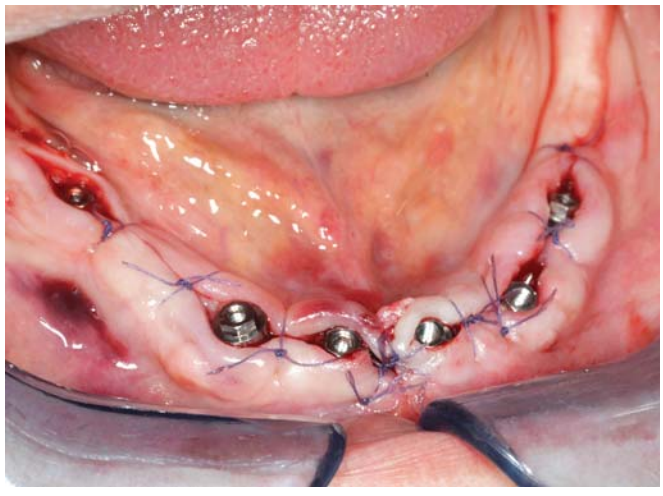

Fig. 18: Intermediary abutments have been placed on the implants and the flap has been closed with interrupted sutures

implant substructure. Additionally, the teeth are fabricated of a composite resin for improved bondability to the base and improved esthetics (Fig. 12). Using the vertysystem as mentioned earlier, a mold was made of the final setup. The wax setup was removed from the cast and a block out was placed on the cast at the crest where the implants would be placed (Fig. 13). A clear acrylic replica was created and a window was cut over the wax blockout to serve as a surgical stent to guide placement of the implants (Figs 14 and 15). Vertical marks were made on the facial of the stent at each implant position and tried intraorally to check fit of the stent (Fig. 16).

Local anesthetic was administered using alphacaine (Dentsply, York, PA, USA); 4% articaine hydrochloride 1/200,000 was placed bilaterally into the buccal vestibule between the first molars. A crestal incision was made starting at the left first molar and continuing at the middling of the crest to the right first molar and a vertical releasing incision was made at the facial midline then a fill thickness flap was elevated. The surgical stent was placed and the initial drill used was a starter drill taken to the determined depth at each site. This was followed by sequential drills to a 3.7 mm diameter in sites where bone density was determined tactilly to be dense. In those sites that felt lower density drilling stopped at the 3.2 mm drill diameter. All drills were utilized at 400 rpm under profuse water irrigation. It was decided to distally incline the implant at the left premolar site due to proximity of the mandibular nerve allowing a longer fixture to be utilized and increase the spread of implants to support the prosthesis. Implants were inserted with a torque control handpiece (W&H, Winsor, Ontario, CN) using a speed of 8 rpm set at 40 Ncm. Upon torque out of the handpiece, final implant insertion was completed with a hand torque wrench (Fig. 17). Intermediary abutments were placed on each implant fixture and the flap was closed with 5-0 polyglycolic acid (PGA) sutures in an interrupted fashion (Fig. 18).

Open tray impression abutments were placed onto the intermediary abutments on each fixture (Fig. 19). Dental floss was looped around the open tray impression heads to

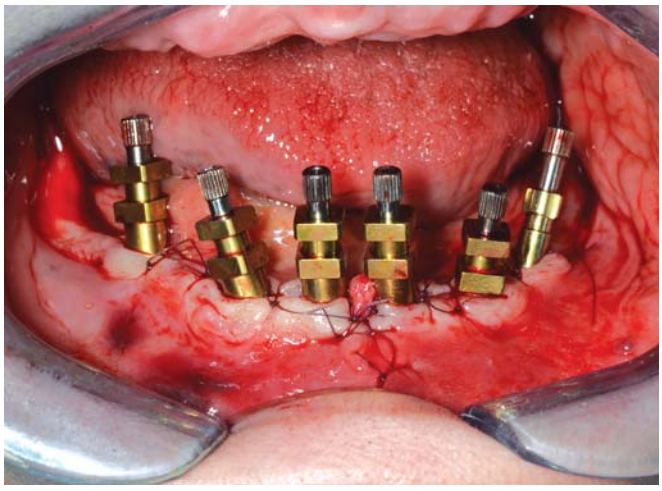

Fig. 19: Open tray impression abutments have been placed onto the intermediary abutments

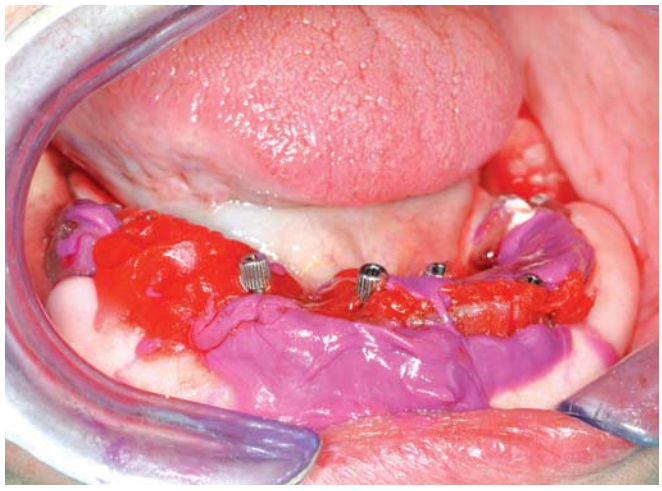

Fig. 21: The custom impression tray has been filled with PVS impression material and inserted in an open tray technique over the verification stent intraorally

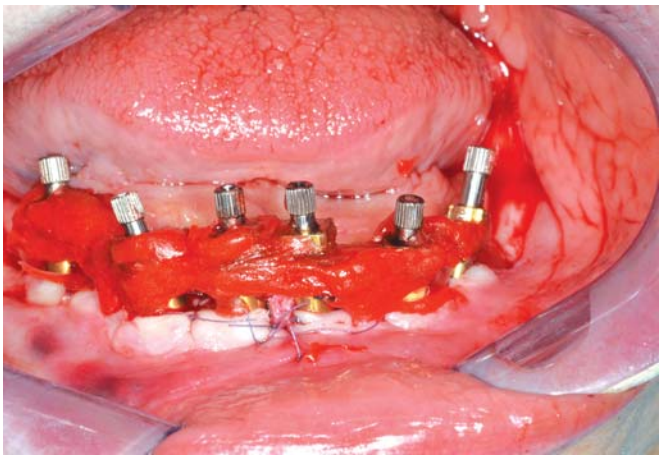

Fig. 20: The open tray impression abutments have been joined in a verification stent with GC pattern resin, a self-cure acrylic

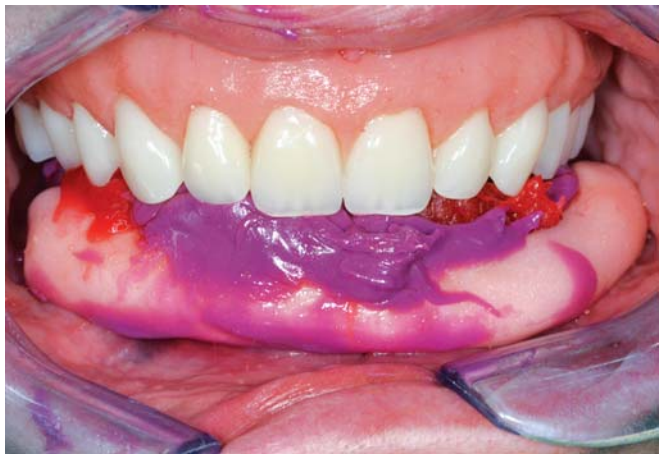

Fig. 22: The patient has been guided into occlusion to capture an intra-arch record to aid in mounting the case

support the verification stent and incrementally GC pattern resin (GC America, Alsip, IL, USA) a self-cure resin in a powder-liquid formulation was brushed on the floss support using a bead and brush technique (Fig. 20). The surgical stent was modified to fit over the verification stent intraorally and vinyl polysiloxane (VPS) adhesive was painted on to retain the impression material to the stent modified tray. A monophase VPS impression material (Aquasil Ultra, Dentsply Caulk, Milford, DE, USA) was placed into the tray and inserted over the verification stent (Fig. 21). Additional impression material was applied over the verification stent and the patient guided into occlusion to aid in mounting the case at the laboratory (Fig. 22). Upon setting the long pins were removed from the impression heads and the verification stent imbedded in the open tray impression was removed intraorally. Healing abutment heads were placed on the intermediary abutments. The patient was prescribed betamethasone 4 mg and 400 mg of ibuprofen and instructed to continue the antibiotics intiated prior to treatment.

Analogs were placed on the impression heads in the open tray impression and a soft tissue model was created. Stock abutments were placed on the implant anologs and modified height wise to fit within a VPS stent made of the wax setup. The abutments were then abraided to improve retention of the resin of the provisional prostheis that would be created (Fig. 23).

The abutments were then painted with Adoro gingival opaque in pink (Ivoclar, Amherst, NY, USA) to aid in blocking out the dark color of the metal abutments (Fig. 24). Ribbond THM in a 2 mm width (Ribbond, Seattle, WA, USA) was cut to a length that would allow it to be 'Figure 8' around the abutments. This reinforcement ribbon was wetted with Heliobond (Ivoclar) a light curable resin and the Ribbond was wrapped around the abutment heads then light-cured creating a rigid fiber reinforced frame for the provisional prosthesis (Fig. 25).

Fig. 23: Stock abutments have been modified then roughed by sand blasting and placed on the master cast

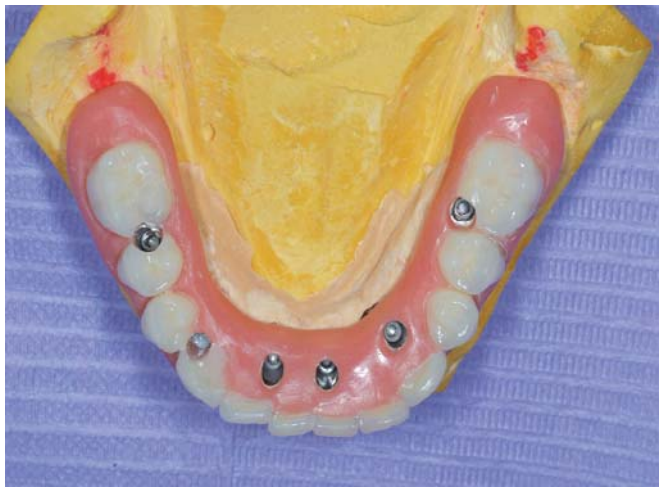

Fig. 26: Occlusal view of the finished Ribbond reinforced acrylic hybrid prosthesis on the master cast

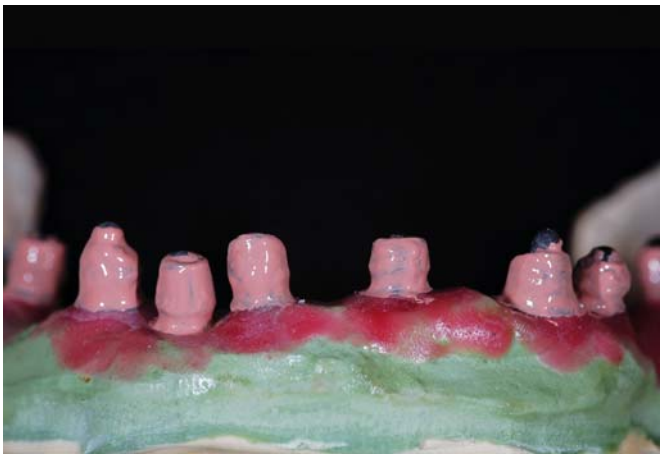

Fig. 24: The abutments have been painted with Ivoclar's Adoro gingival opaque in pink to block out the metal color to prevent show through on the final prosthesis

Fig. 27: Facial view of the finished Ribbond reinforced acrylic hybrid prosthesis on the master cast

Fig. 25: Ribbond reinforcement ribbon is wound around the prepared abutment heads to create rigid reinforcement in the prosthesis adding to its strength to prevent potential prosthesis fracture

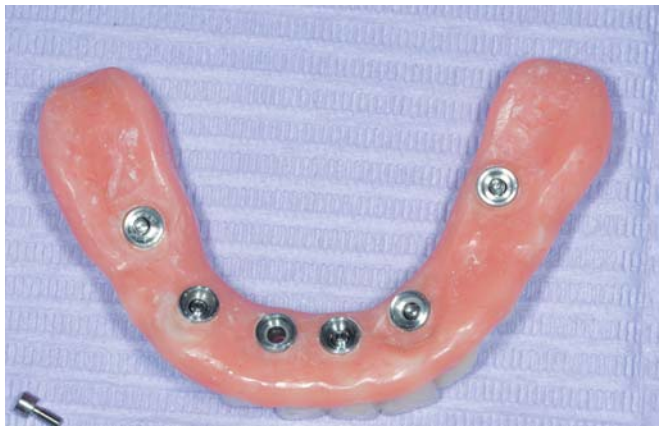

Fig. 28: Tissue side of the finished Ribbond reinforced mandibular hybrid prosthesis

The visio.lign teeth were inserted into the VPS stent and placed upon the cast and Combipress N (Merz Dental, Lujenburg, Germany) a gingival shaded cold cure acrylic was mixed and poured into the VPS stent to backfill the space between the teeth and frame and cover the lingual aspect then allowed to set. The stent was removed and the

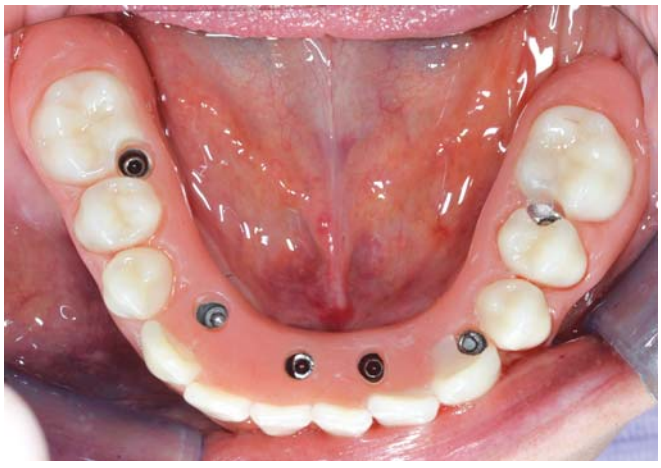

Fig. 29: Finished Ribbond reinforced acrylic hybrid prosthesis intraorally

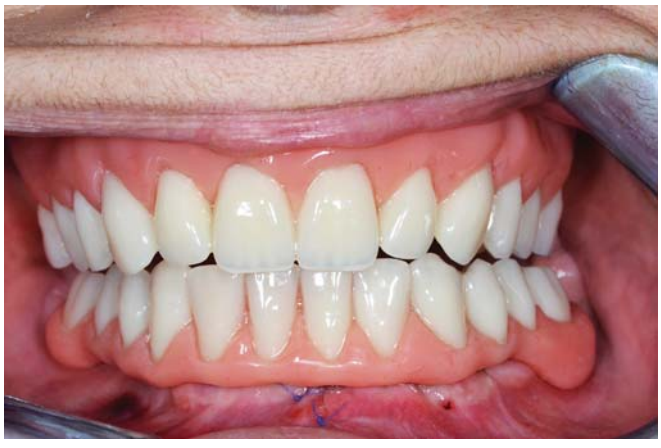

Fig. 30: Final prosthesis with a conventional full maxillary denture and a mandibular immediate load Ribbond reinforced acrylic hybrid prosthesis

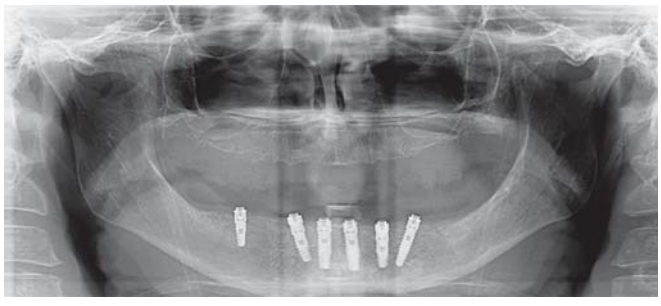

Fig. 31: Radiograph of the final immediate load Ribbond reinforced mandibular hybrid prosthesis on the implants

provisional prosthesis was finished and polished (Figs 26 and 27). The lingual surface was shaped to eliminate the flanges and create a cleansable prosthesis (Fig. 28).

Eight hours following implant placement the patient return to the clinic and the healing abutments were removed. The provisional prosthesis was inserted and the fixation screws were hand tightened (Fig. 29). A radiograph was taken to verify mating of the prosthesis with each fixture. Following confirmation of complete seating, each fixation screw was tighten to 30 Ncm with a torque wrench. Occlusion was checked and adjusted as needed (Fig. 30). A panoramic radiograph was taken of the provisional fiber reinforced prosthesis to document bone levels for future monitoring (Fig. 31).

CONCLUSION

Immediate implant placement and provisionalization allows the patient to return to function, although diet limited. The key to success with this treatment option is rigidity of the provisional prosthesis. Any flexure may allow uneven load distribution to the individual fixtures and lead to failure of one or more of the fixtures during the healing phase. Fiber reinforcement with Ribbond allows rapid prosthesis fabrication at a lower cost then custom cast frames and stronger then wire reinforced prosthesis.

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