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Maintenance of Implant Hybrid Prostheses: Clinical and Laboratory Procedures

Carl Drago, DDS, MS[1] & Lynn Gurney, DDS[2]

[1]Eon Clinics, Waukesha, WI; formerly Associate Professor, Department of Prosthetic and Restorative Dentistry, The Ohio State University College of Dentistry, Columbus, OH
[2]Advanced Prosthodontics, The Ohio State University College of Dentistry, Columbus, OH

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Correspondence
Carl Drago, Eon Clinics, 20700 Swenson Dr., Pewaukee, WI 53072.
E-mail: carl.drago@gmail.com

Dr. Carl Drago is a consultant for Biomet 3i, Palm Beach Gardens, FL

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Abstract

Fixed implant hybrid prostheses have been used for the last 40+ years in the treatment of edentulous patients. These prostheses have provided long-term masticatory function for thousands of patients. The original treatment protocol included fabrication of cast metal frameworks that fit accurately on the restorative platforms or abutments and/or endosseous implants. Frameworks were designed to splint implants together; they also provided retention and support for the functional and esthetic portions of the fixed hybrid prostheses. Initially, edentulous patients were treated with maxillary complete dentures and mandibular fixed, hybrid prostheses. Denture teeth were used in both prostheses. Over the span of many years, occlusal surfaces of the denture teeth in the mandibular prostheses exhibited signs of occlusal abrasion and wear, sometimes completely abrading the teeth and denture bases, resulting in framework exposures. Ultimately, this resulted in decreased chewing efficiency and loss of vertical facial height. Patients would then return to clinicians and ask for retreatment. In certain instances, the underlying frameworks would have to be remade. This involved replicating the original series of appointments and significant additional expense to patients and clinicians alike. The protocol presented in this article avoids having to remake the most expensive portion of fixed implant prostheses—the frameworks. The protocol identifies the clinical and laboratory procedures involved in using existing frameworks and replacing preexisting denture bases and denture teeth, with minimal inconvenience to patients.

Osseointegration of endosseous dental implants was originally defined as a firm, direct, and lasting connection between vital bone and screw-shaped titanium implants with certain defined finishes and geometries.[1] At the light microscopic level, osseointegrated implants demonstrate no evidence of soft tissue between bone and implants. Adell et al[1] stated that osseointegration could only be achieved and maintained with gentle surgical implant placement techniques, long, unloaded healing times that were jaw specific, and appropriate stress distribution during masticatory function. In a 15-year study that included 410 jaws in 371 patients, Adell et al reported 81% of maxillary and 91% of mandibular implants remained stable, and supported the fixed hybrid prostheses in the clinical study. Adell et al reported cumulative prosthesis survival rates of 89% and 100% for maxillary and mandibular prostheses, respectively.

Treatment protocols have changed significantly over the past 30 years. One significant modification involved clinicians placing implants into edentulous jaws with high insertion torques and immediately loading multiple implants splinted together with all-acrylic resin fixed prostheses. Pieri et al reported 1-year clinical results of immediately loaded implants that included an implant cumulative survival rate of 98.6% and a prosthesis survival rate of 100%.[2] Other authors have reported similar findings.[3–6]

Maintenance of implant-supported/retained prostheses is an important part of clinical practice. Chung et al reported the results of a retrospective review of 69 patients treated in the University of Washington Graduate Prosthodontic Program between 1988 and 2000. They reported an implant survival rate of 96.3% and a prosthesis survival rate of 85.4%. Prostheses demonstrated higher failure rates than implants.[5] In the edentulous group, two prostheses were judged to be failures. In both cases, denture tooth occlusal wear resulted in the need to replace denture teeth in the fixed prostheses; however, the authors also noted that the known life expectancy and properties associated with methyl methacrylate denture teeth was probably one of the causes of the noted failures, and found it difficult to characterize these conditions as true prosthetic failures. This

would have altered the relatively high prosthetic failure rate of approximately 15%.

Jemt and Johansson reported the results of 15 years of clinical follow-up of edentulous maxillary patients relative to implant and prosthodontic complications.[7] They reported the results of 32 patients (203 machined Branemark implants) that included 37 implant and 5 fixed hybrid maxillary prostheses failures. Fifteen-year survival rates were 90.9% for implants and 90.6% for prostheses. They also reported that resin veneer fractures were highest in the beginning of the clinical period; severe wear increased in the later stages of follow up. They noted that wear and veneer fractures were time related during the clinical course of the study.

Purcell et al reported the results of a retrospective chart review of patients treated with maxillary complete dentures and mandibular metal-resin implant fixed complete dental prostheses (hybrids).[8] Dental records of 46 patients treated with the above clinical procedures were reviewed; prosthetic complications were recorded. The average recall time at the time of the chart review was 7.9 years. Purcell et al reported a statistically significant finding relative to complete denture relines, posterior tooth replacement, and screw complications. They stated that patients were 52.5 times more likely to replace posterior denture teeth 5 years after placement than with less than 2 functional years. Posterior teeth replacement in hybrid prostheses was required more frequently than replacement of maxillary complete denture posterior teeth (47.7% and 19.6%, respectively). New maxillary complete dentures were fabricated for 30.4% of the patients. Purcell et al noted that new maxillary dentures were made secondary to a combination of posterior tooth wear and the need for processed laboratory relines. They noted the incidence for posterior tooth replacement for maxillary and mandibular prostheses at equally high levels for recalls 5 years post-occlusal loading. Purcell et al also noted that the three most common prosthetic complications in their study were replacing acrylic resin posterior teeth secondary to occlusal abrasion, maxillary complete denture laboratory processed relines, and fractured acrylic resin anterior denture teeth.

In a recent review article, Layton identified survival and complication rates associated with all-ceramic fixed restorations (tooth-supported) as compared to survival and complication rates of porcelain-fused-to-metal (PFM) fixed restorations (tooth-supported).[9] She noted numerous limitations during collection of the data, including compromised internal validity of published studies, outcome definitions that were less than specific, inaccurate results, and lack of definitive, reproducible follow-up examinations and results. After all of the above were described, Layton concluded that PFM fixed restorations had significantly higher 5-year survival rates than did all-ceramic fixed restorations. She also noted that differences in complication rates via published systematic reviews were unknown, but the published evidence suggested that complication rates of PFM fixed implant restorations were lower than those of all-ceramic fixed implant restorations.[9-11] Layton made a strong case in noting the difficulties in attempting to compare data from different studies, because data were not consistently recorded from study to study. She stressed that further studies to assess complication rates of metal-ceramic FDPs and of different all-ceramic FDP constructions would be clinically helpful.

Fabrication of implant fixed hybrid prostheses is technically demanding and requires clinicians and dental laboratory technicians to use fixed and removable prosthodontic principles and techniques. Fixed hybrid prostheses are time consuming and expensive to fabricate. In the authors' experience, conventional acrylic resin denture teeth have a life expectancy of approximately 7 to 9 years prior to needing replacement. Given that laboratory fees associated with fixed hybrid implant prostheses generally run in the range of $3000 to $5000, it appears to be prudent to minimize the costs associated with remaking the occlusal surfaces of these prostheses by reusing, if possible, the original frameworks; however, this is a time-intensive effort and generally requires that edentulous patients go without the original prostheses while the new denture teeth and bases are applied to the frameworks.

Endosseous, titanium, dental implants have provided thousands of patients with support for fixed and removable implant restorations on a long-term basis. Osseointegration of dental implants has provided edentulous patients with the means to regain relatively normal function; however, the prosthetic materials associated with fixed implant prostheses are subject to the wear and tear associated with mastication and para-functional habits. The purpose of this article is to illustrate one clinical and laboratory protocol used to replace worn acrylic resin teeth without replacing the metal framework; a new maxillary denture was also fabricated. The article also illustrates the time sequence associated with this treatment.

Clinical report

A 68-year-old female patient presented to The Ohio State University Advanced Prosthodontic Clinic (Columbus, OH) for a yearly recall appointment with the chief complaint, "My teeth are ugly. They are small and worn. I can't eat. Food seems to fall off my teeth, especially carrots. I don't like the way my gums look. They're orange" (Figs 1–3).

This patient had been treated by one of the postdoctoral graduate students approximately 17 years previous to this appointment with a maxillary complete denture and a mandibular fixed hybrid implant-retained prosthesis ad modum Branemark. Nine years later, the mandibular posterior teeth were replaced with new acrylic resin denture teeth; a new maxillary complete denture was also fabricated.

The physical examination revealed an occlusal vertical dimension (OVD) within normal limits, consistent with the patient's age. There were no intraoral lesions or other soft tissue abnormalities.

The authors felt that the patient's chief complaint was valid in that the OVD was decreased secondary to occlusal wear of the denture teeth and continued bone resorption in her maxillary jaw. The endosseous implants appeared to be osseointegrated; the preexisting framework was intact and still fit well. The patient appeared to have adequate maxillary bone to support implants in the maxillary jaw. If the patient did not wish to pursue maxillary implants prior to prosthetic treatment, the treatment plan would consist of a new maxillary denture and replacement of the mandibular teeth and denture base using the preexisting cast metal framework.

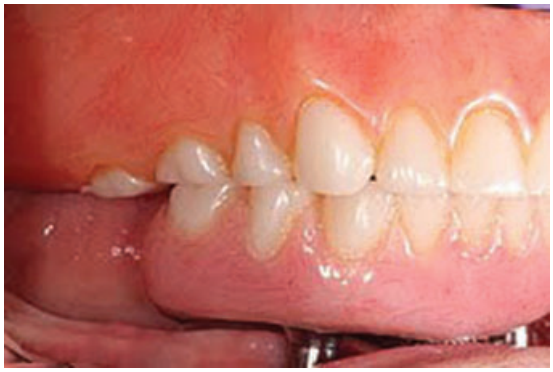

Figure 1 Preoperative clinical right posterior image: centric occlusion. Note the significant wear and loss of anatomy of the posterior denture teeth.

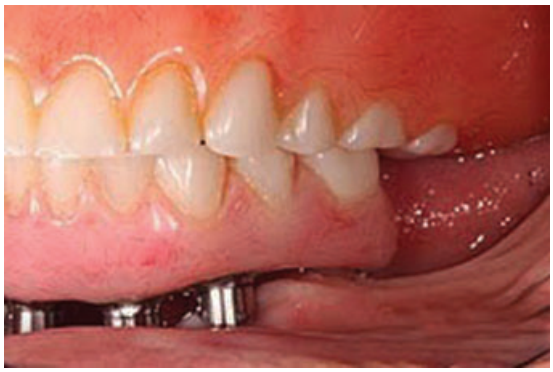

Figure 2 Preoperative clinical left posterior image: centric occlusion. Note the significant wear and loss of anatomy of the posterior denture teeth.

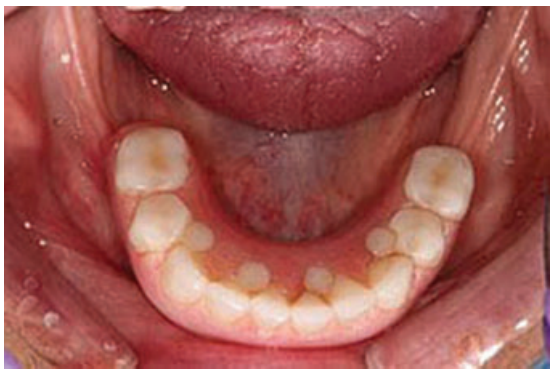

Figure 3 Preoperative clinical occlusal image of the mandibular prosthesis. Note the significant wear and loss of anatomy of the denture teeth.

Although the patient presented with adequate bone volume for maxillary implants, she declined that treatment option; the authors proceeded in treating this patient with a new, maxillary complete denture. Successful accommodation of patients to complete dentures is not based solely on the adequacy of the prosthodontic treatment.[6] Some clinicians have stated that successful clinical management of edentulous patients has been correlated with technical procedures used during fabrication of complete dentures. Recent data strongly suggest that patient-based measures of denture success may differ from clinician-based measures of evaluating clinical success in complete denture patients.[12]

Clinical and laboratory appointment sequence

To minimize inconvenience to the patient regarding removal and reuse of the preexisting mandibular prosthesis during treatment, a series of patient clinical and laboratory appointments were arranged (Table 1). This appointment sequence minimized the amount of time the patient would be without the mandibular prosthesis (2 days); more significantly, it also spared her the expense of making a new implant-retained framework. This sequence was possible to accomplish in a short period because one of the authors (LG) performed the requisite laboratory work. The authors believe this sequence could also be accomplished in the private sector with appropriate scheduling between restorative dental offices and commercial dental laboratories. The authors are also aware that this protocol would not be successful if patients would not tolerate being without the preexisting implant-retained prosthesis.

Appointment 1

The objective of the complete denture definitive impression is to accurately record the entire denture-bearing area to produce a stable and retentive prosthesis, while maintaining patient comfort, esthetics, and preservation of the remaining tissues.[13] Preliminary impressions were made with alginate, in stock trays, to fabricate diagnostic casts of the edentulous maxilla and mandibular fixed hybrid prosthesis. The patient continued to wear the mandibular prosthesis. A maxillary custom impression tray was fabricated on the maxillary diagnostic cast.

Appointment 2

The objectives of impressions for complete dentures are to provide support, retention, and stability to removable prostheses.[14] Accurate impressions are important in fabricating stable and retentive prostheses for optimal esthetics, function, and comfort. Davis stated that "Proper space for the selected impression material should be provided within the impression tray."[14] In this case, the maxillary custom impression tray was made directly on the surface of the maxillary diagnostic cast, without the benefit of a spacer.[15] The authors felt that pressure could be placed more accurately through the impression tray directly onto the posterior ridges without having a spacer applied to the cast prior to construction of the tray. The impression tray was made from visible light-cured resin, following the manufacturer's instructions (Triad®, Dentsply Int., York, PA). Border molding was accomplished with heavy body poly(vinyl siloxane) (PVS) impression material (VP Mix™ HP, Henry Schein, Melville, NY); the definitive impression was made with regular PVS impression material (VP Mix™ HP).[13] The master cast was made in conventional fashion. A maxillary record base with wax occlusion rim was fabricated using conventional measurements

Table 1 Clinic and laboratory appointment schedule

Appointments	Mon AM	Mon PM	Tues AM	Tues PM	Wed AM	Thur PM	Fri AM
Clinic	Diagnostic impressions; order implant components	Maxillary definitive denture impression	Initial jaw relation records; select denture teeth	Maxillary wax denture try-in; remove preexisting mandibular hybrid prosthesis; place healing caps	Wax try-in no. 2; verify esthetics, OVD, jaw relations	Remove healing caps; insert prostheses; evaluate occlusion; polish; torque screws; restore access openings	24-hour post-insertion office visit; evaluate occlusion, tissue adaptation, oral hygiene
Laboratory	Pour casts; construct maxillary custom denture impression tray	Pour master cast; fabricate maxillary record base and occlusion rim	Articulator mounting; set maxillary denture teeth	Make mandibular master cast with lab analogs; remove denture teeth and base from mandibular prosthesis; set mandibular teeth for try-in	Remount as needed; Reset teeth, final waxing, process, and finish		

(22 mm height in anterior segment; 18 mm height in posterior segment).

Appointment 3

Record bases and occlusion rims are key elements in transferring clinical information relative to edentulous patients to dental laboratory technicians: skeletal/dental jaw relationships; dental midlines; locations of the occlusal/incisal planes; location of the anterior gingival margins; location of the maxillary canine teeth; amount of vertical and horizontal overlap, lip support, and the location of the posterior teeth relative to the buccal corridors. The clinical appointment for accurately establishing jaw relationships is sometimes overlooked by clinicians.[16] It is essential that the jaw relation record be accurate relative to OVD and centric jaw relationships.

The incisal plane was established by contouring the maxillary occlusion rim parallel to the inter-pupillary line and at a height that would be representative of the amount of incisor tooth length wished for by the patient. The posterior occlusal plane was made parallel to the ala-tragus line.[17]

Numerous methods have been identified relative to recording the rest vertical dimension (RVD) and the OVD in edentulous patients.[18-21] Dots were placed onto the patient's face: one on the nose, one on the chin. In this case, the patient was asked to wet her lips and slowly close her mouth until her lips touched. This was taken as the RVD (Fig 4).[16] Arbitrarily, 3 mm was subtracted from this measurement for the initial, tentative measurement of the OVD. Per Zarb and Finer,[17] the actual method of transferring centric jaw relation records to articulators may be irrelevant. Again, per Zarb and Finer, what is essential is that the record is correctly mounted on the articulator before proceeding with denture set-ups. The initial interocclusal record in this case was made with aluminum impregnated wax (Aluwax™, Aluwax Dental Products Company, Allendale, MI). The authors realized that, as the patient was still wearing the worn mandibular fixed prosthesis, this OVD was probably decreased relative to the OVD to be established with the new prostheses. The facial midline was marked on the maxillary occlusion rim; denture teeth were selected. The patient was discharged to return for the initial wax try-in.

One can make an argument that this type of prosthodontic treatment incorporates principles in fixed and removable prosthodontics. Facebows are caliper-like devices used to record relationships between jaws and the opening axis of mandibular movement.[16] Kinematic hinge axis mountings may be appropriate for complete occlusal rehabilitation procedures for patients with natural teeth; arbitrary hinge axis mounting maxillary casts may be appropriate for removable prosthodontic treatments.[22] Authors in one noted prosthodontic textbook have identified the need for facebow records and the potential criticality of these records to avoid errors in occlusion.[16] Anderson[16] acknowledged that there are theoretical advantages associated with using facebow records for orientation of casts to articulator hinge axes; however, Anderson also stated that the theoretical advantages may not transfer to produce a better clinical end result. In this case, the casts were mounted arbitrarily in a simple hinge articulator with the occlusal and incisal planes horizontal. The authors appreciate that this type

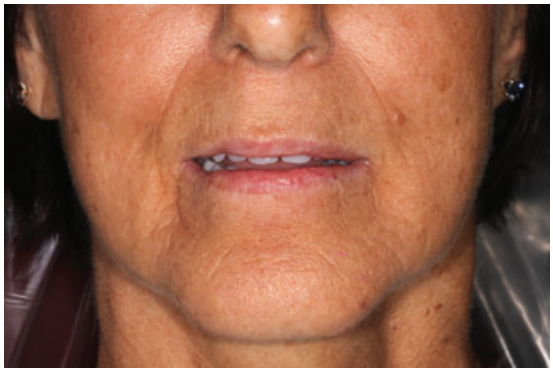

Figure 4 Clinical image of the patient at rest with the preexisting prostheses. This was used as one of the determinants regarding a new, increased vertical dimension of rest position.

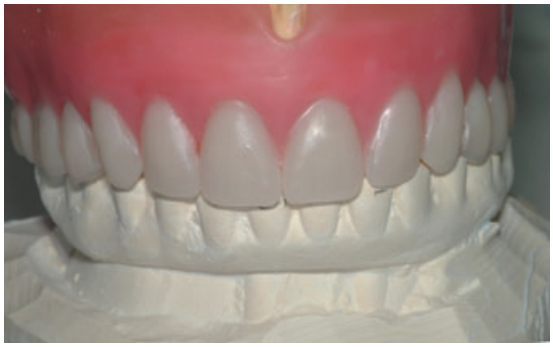

Figure 5 Laboratory image of the maxillary wax denture prior to the clinical try-in.

of articulator mounting protocol may raise concerns regarding accurate occlusal assessment of dynamic articulations in excursive movements, as well as in a static centric relation position. It is also well known that the vast majority of prosthodontic procedures are conducted in this fashion. Shelley and Plummer surveyed commercial dental laboratories specializing in removable dental prosthetics in three major Texas cities to determine whether dentists submitted adequate records and information for complete denture prosthodontics. They reported that the dentists in the survey routinely requested services without providing adequate records.[23]

At this point in time the mandibular cast replicated the preexisting mandibular fixed prosthesis, as the patient continued to wear the prosthesis. The maxillary midline was centered, and the casts were mounted in the middle of the articulator. The casts were mounted with mounting stone (Whip Mix Corporation, Louisville, KY) at the recorded OVD.

Denture teeth were set consistent with the contours of the maxillary occlusion rim for the wax try-in. With the increased use of dental implants and the resultant increased forces generated on the prosthetic components, Moffitt et al have postulated that it is likely that tooth debonding or fracture will probably become an even greater clinical challenge.[24] Ivoclar Vivadent denture teeth are manufactured with a layering technique whereby hardened, double cross-linked acrylic resin PMMA

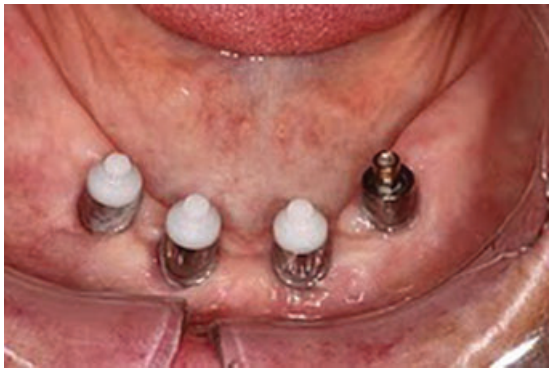

Figure 6 Clinical image of the patient with three healing caps in place after removal of the preexisting mandibular implant prosthesis. The left posterior abutment had a retaining screw in place to protect the internal threads of the abutment screw in the standard abutment. Healing caps were used to protect the patient's tongue from the sharp line angles associated with the standard abutments.

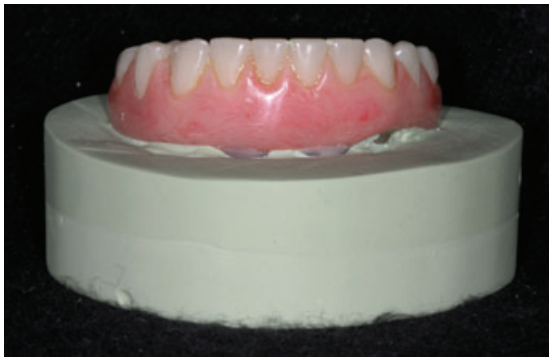

Figure 7 Laboratory abutment analogs were placed onto the implant restorative platforms of the preexisting framework to fabricate the mandibular master cast.

denture teeth with three layers are made. Other denture teeth are made with an interpenetrating polymer network of acrylic resin (Trubyte Portrait IPN Bioblend, Dentsply). Moffitt et al reported that these types of denture teeth fractured at higher compression forces than the average maximum occlusal forces reported in natural dentitions. Anterior and posterior teeth were selected consistent with the esthetic desires of the patient (SR Phonares NHC anterior; SR Phonares NHC posterior, Ivoclar Vivadent Inc., Amherst, NY). These teeth were set for optimal cusp/fossae centric contacts: group function occlusion in right and left working movements (Fig 5).

Appointment 4

This was the wax try-in appointment for the new maxillary denture. The patient and one of the authors evaluated the esthetics, lip support, OVD, and RVD of the maxillary wax denture. The patient agreed to the esthetics of the maxillary wax denture; she declined to bring anyone to the wax try-in appointment. The authors realized that the OVD was not fully corrected at this appointment, as this was accomplished with the preexisting mandibular implant prosthesis still in place.

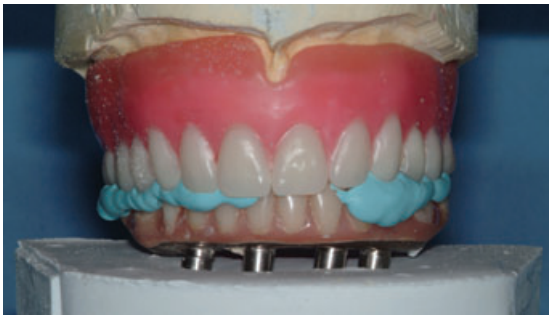

Figure 8 Laboratory image of the preexisting fixed prosthesis mounted against the maxillary wax denture. The interocclusal record was made with poly(vinyl siloxane) material.

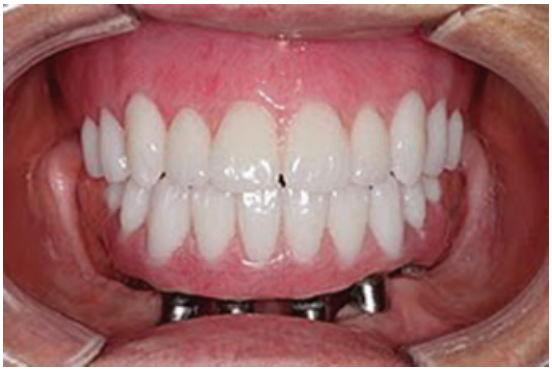

Figure 9 Clinical image of the completed prostheses: anterior centric occlusion.

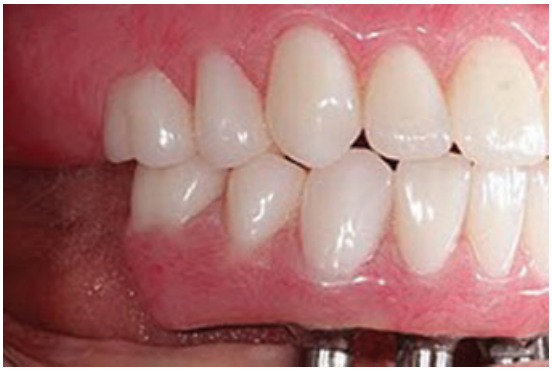

Figure 10 Clinical image of the completed prostheses: right centric occlusion.

A new centric jaw relation record, at a tentative new OVD, was made with PVS interocclusal registration material (Blu Mousse®, Parkell Inc., Edgewood, NY) so the mandibular prosthesis could be mounted against the maxillary wax denture in the articulator. The authors used this occlusal registration material, as it was more easily manipulated and removed from the occlusal surfaces of the prostheses than the wax used for the initial jaw relation records. Improved accuracy of PVS versus wax was not necessarily a determining factor, as research

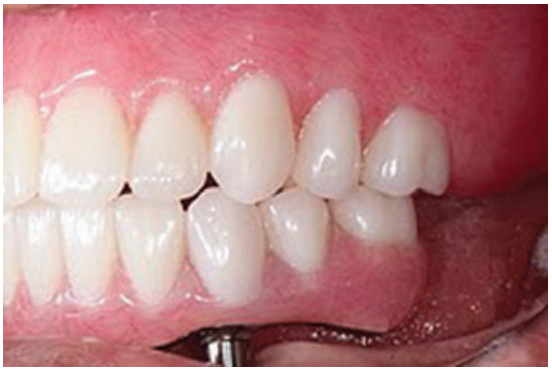

Figure 11 Clinical image of the completed prostheses: left centric occlusion.

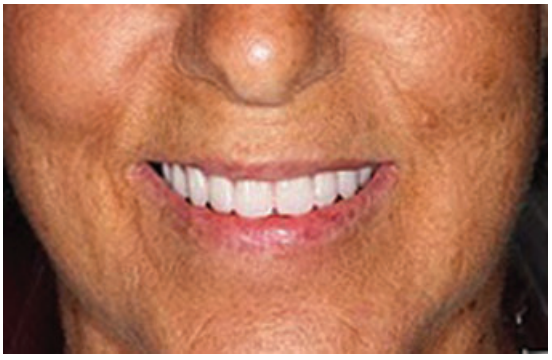

Figure 12 Clinical image of the patient smiling, with completed prostheses in place: smile.

has not demonstrated conclusively that one material is more accurate than the other.[25]

The mandibular prosthesis was removed by removing the screw access restorations, cotton block-out material, and retaining screws. The abutments were 5 mm in height, external hex, multi-unit abutments (Ref. no. 29183, Nobel Biocare USA, LLC, Yorba Linda, CA). The abutment screws (Nobel Biocare USA, LLC) were torqued to 20 Ncm. Healing caps (Ref no. 35989) were placed onto the abutments (finger tight) to protect the patient's tongue from the sharp line angles of the abutments (Fig 6).

This prosthesis was originally designed with 5 mm transmucosal standard abutments. Consequently, there was a large amount of space between the tissue surface of the prosthesis and the peri-implant soft tissues. An impression that recorded the relationship between the prosthesis and the mandibular soft tissues was not needed; the preexisting prosthesis was designed without soft tissue contact. Zarb and Eckert stated that fixed implant prosthesis design includes principles borrowed from fixed and removable prosthetic protocols.[26] This framework had been designed with buccal/labial and lingual finish lines.

To save the patient additional expenses associated with a second implant-retained framework, it was decided to use the implant-retained prosthesis as the verification index to make the mandibular master cast (Fig 7). After the prosthesis was removed from the implants, laboratory screws (no. 29287) were

placed into the screw access openings and screwed into new abutment replicas (31159). All of the above components were manufactured by Nobel Biocare USA LLC.

Type IV dental stone was vacuum-mixed as per the manufacturer's instruction and vibrated into a plastic mold used to make bases for dental casts. (GC Fuji Rock® EP, GC America Inc., Alsip, IL). The preexisting framework, with the abutment replicas in place, was gently vibrated into the stone so that the replicas were embedded into the stone. The stone was allowed to set.

The mandibular cast and preexisting mandibular prosthesis were mounted to the maxillary wax denture with the interocclusal record and mounting stone (Whip Mix Corporation) mixed according to the manufacturer's instructions (Fig 8). The OVD was increased by approximately 2 mm at the incisal guide table from the original OVD with the preexisting prostheses. The locations of the mandibular incisal edges were therefore raised such that they would be visible during speech, per the patient's request. The denture teeth and denture base were removed from the preexisting mandibular prosthesis by grinding and shell blasting.

Interarch space was considered to be adequate. The preexisting macro-mechanical retention in the original framework was adequate, but additional retention with chemical bonding was accomplished to improve the longevity of the denture base/framework connection; the resin also opaqued the metal framework (SiliClean, SiliLink, Heraeus Kulzer, Armonk, NY). The framework and the opaque resin were placed into a Silicoater MD oven for curing. The mandibular denture teeth were set consistent with the positions of the denture teeth in the wax maxillary denture.

Appointment 5

The patient and one of the authors (LG) evaluated the esthetics, lip support, OVD, and RVD of the wax prostheses at the wax try-in appointment. The co-author (LG) evaluated the accuracy of the jaw relation record per the above parameters and determined it was accurate. The patient accepted the new esthetics; the prostheses were ready to be processed and finished. The prostheses were waxed, flasked, boiled-out, and processed in conventional fashion. The prostheses were finished and polished; the patient was reappointed for insertion.

Appointment 6

The healing caps were removed from the mandibular abutments. Abutment screws were re-torqued to 20 Ncm with a torque device. The mandibular prosthesis went to place without incident. Try-in screws were used for this portion of the appointment

Pressure indicating paste was applied to the intaglio surface of the maxillary denture; the denture was inserted and evaluated for pressure areas. Adjustments were made as needed to achieve complete seating of the maxillary denture with tissue contact throughout the intaglio surface. The occlusion was evaluated in centric, right, left, and protrusive positions (Figs 9–11). A new interocclusal record was made with PVS interocclusal registration material (Blu Mousse); the prostheses were remounted in the laboratory. Occlusal adjustments were made such that the patient had even occlusal contacts in the posterior segments and lighter contacts anteriorly. The patient was extremely pleased with the results (Fig 12).

Retaining screws (no. 32983, Nobel Biocare) were placed and torqued to 10 Ncm with a torque driver. The screw heads were blocked out with cotton pellets; access openings were restored with tooth-colored, light-cured composite resin.

Appointment 7

The patient returned for the 24-hour follow-up appointment and reported no problems with either of the prostheses. She was extremely pleased with the results of treatment. The long-term prognosis was considered to be favorable.

Conclusion

Numerous authors have reported clinical challenges associated with fixed implant prostheses, including resin veneer fractures and occlusal wear. The treatment sequence presented in this article illustrated one specific protocol that the authors used to repair/maintain a preexisting, mandibular fixed implant hybrid prosthesis. This treatment protocol required that the patient be without the implant prosthesis for 2 full days, but it saved the patient from having, at significant expense, a completely new framework and implant prosthesis constructed. This particular treatment modality resulted in minimal inconvenience to the patient. In a non-academic setting, this protocol would require the logistical support of a commercial or in-house dental laboratory technician. In cases where restorative dentists do not possess the requisite laboratory equipment, dental laboratory technicians have performed the prosthodontic laboratory procedures in their offices. In these cases, technicians have brought their own laboratory equipment, materials, and implant components with them to the restorative offices. To facilitate treatment per this protocol, the authors suggest that appointments be scheduled with commercial dental laboratories, such that all parties are aware of their respective responsibilities; the prostheses could then be fabricated in a timely fashion. With the advent of new, stronger denture teeth, the frequency with which this protocol may be needed may be decreased relative to the frequencies that have been reported in the past.

References

1. Adell R, Lekholm U, Rockler B, et al: A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981;10:387-416
2. Pieri F, Aldini NN, Fini M, et al: Immediate occlusal loading of immediately placed implants supporting fixed restorations in completely edentulous arches: a 1-year prospective pilot study. J Periodontol 2009;80:411-421
3. Degidi M, Iezzi G, Perrotti V, et al: Comparative analysis of immediate functional loading and immediate nonfunctional loading to traditional healing periods: a 5-year follow-up of 550 dental implants. Clin Implant Dent Relat Res 2009;11:257-266
4. Tealdo T, Bevilacqua M, Menini M, et al: Immediate versus delayed loading of dental implants in edentulous maxillae: a 36-month prospective study. Int J Prosthodont 2011;24:294-302
5. Chung WE, Rubenstein JE, Phillips KM, et al: Outcomes assessment of patients treated with osseointegrated dental

implants at the University of Washington Graduate Prosthodontic Program, 1988 to 2000. Int J Oral Maxillofac Implants 2009;24:927-935
6. Cooper L: Current and future treatment of edentulism. J Prosthodont 2009;18:116-122
7. Jemt T, Johansson J: Implant treatment in the edentulous maxillae: a 15-year follow-up study on 76 consecutive patients provided with fixed prostheses. Clin Implant Dent Relat Res 2006;8:61-69
8. Purcell BA, McGlumphy EA, Holloway JA, et al: Prosthetic complications in mandibular metal-resin implant-fixed complete dental prostheses: a 5- to 9-year analysis. Int J Oral Maxillofac Implants 2008;23:847-857
9. Layton D: A critical appraisal of the survival and complication rates of tooth-supported all-ceramic and metal-ceramic fixed dental prostheses: the application of evidence-based dentistry. Int J Prosthodont 2011;24:417-427
10. Sailer I, Pjetursson B, Zwahlen M, et al: A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part II: fixed dental prostheses. Clin Oral Implants Res 2007;18(suppl 3):86-96
11. Walton TR: Changes in the outcome of metal-ceramic tooth-supported single crowns and FDPs following the introduction of osseointegrated implant dentistry into a prosthodontic practice. Int J Prosthodont 2009;22:260-267
12. Ellis J, Pelekis N, Thomason J: Conventional rehabilitation of edentulous patients: the impact on oral health-related quality of life and patient satisfaction. J Prosthodont 2007;16:37-42
13. Chaffee NR, Cooper LF, Felton DA: A technique for border molding edentulous impressions using vinyl polysiloxane material. J Prosthodont 1999;8:129-134
14. Davis D: Developing an analogue/substitute for the maxillary denture-bearing area. In Zarb GA, Bolender CL, Jacob R, et al (eds): Prosthodontic Treatment for Edentulous Patients-Complete Dentures and Implant-Supported Prostheses (ed 12). St Louis, Mosby, 2004, pp. 211-231
15. Drago CJ: Comparison of post-insertion adjustments with two final impression techniques in complete denture prosthodontics. J Prosthodont 2003;12:192-197
16. Anderson J: Biological and clinical considerations in making jaw relation records and transferring records from the patient to the articulator. In Zarb GA, Bolender CL, Jacob R, et al (eds): Prosthodontic Treatment for Edentulous Patients-Complete Dentures and Implant-Supported Prostheses (ed 12). St Louis, Mosby, 2004, pp. 268-297
17. Zarb G, Finer Y: Identification of shape and location of arch form: the occlusion rim and recording of trial denture base. In Zarb GA, Bolender CL, Jacob R, et al (eds): Prosthodontic Treatment for Edentulous Patients-Complete Dentures and Implant-Supported Prostheses (ed 12). St Louis, Mosby, 2004, pp. 252-267
18. Dervis E: The influence of the accuracy of the intermaxillary relations on the use of complete dentures: a clinical evaluation. J Oral Rehabil 2004;31:35-41
19. Millet C, Leterme A, Jeannin C, et al: Vertical dimension in the treatment of the edentulous patient. Rev Stomatol Chir Maxillofac 2010;111:315-330
20. De Souza RF, Marra J, Pero AC, et al: Effect of denture fabrication and wear on closest speaking space and interocclusal distance during deglutition. J Prosthet Dent 2007;97: 381-388
21. Millet C, Jeannin C, Vincent B, et al: Report on the determination of occlusal vertical dimension and centric relation using swallowing in edentulous patients. J Oral Rehabil 2003;30:1118-1122
22. Carr A, McGivney G, Brown D: Occlusal relationships for removable partial dentures. In Carr AB, McGivney GP, Brown DT (eds): McCracken's Removable Partial Prosthodontics (ed 11). St Louis, Mosby, 2005, pp. 306-313
23. Shelley J, Plummer K: Removable prosthodontic laboratory survey. J Prosthet Dent 1992;67:567-568
24. Moffitt AR, Woody RD, Parel SM, et al: Failure modes with point loading of three commercially available denture teeth. J Prosthodont 2008;17:432-438
25. Eriksson A, Ockert-Eriksson G, Lockowandt P, et al: Clinical factors and clinical variation influencing the reproducibility of interocclusal recording methods. Br Dent J 2002;192: 395-400
26. Zarb G, Eckert S: Clinical protocol: implant-supported fixed prostheses. In Zarb GA, Bolender CL, Jacob R, et al (eds): Prosthodontic Treatment for Edentulous Patients-Complete Dentures and Implant-Supported Prostheses (ed 12). St Louis, Mosby, 2004, pp. 510-515