Consideration of Aesthetic and Restorative Spaces: A Protocol for the Fabrication of Definitive Implant-Supported Overdentures

Authored by Joseph J. Massad, DDS; Swati Ahuja, BDS, MDS; and Mahesh Verma, BDS, MDS, MBA, PhD (HC)

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**Consideration of Aesthetic and Restorative Spaces: A Protocol for the Fabrication of Definitive Implant-Supported Overdentures**

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**ABOUT THE AUTHORS**

**Dr. Massad** is an associate professor in the department of graduate prosthodontics at University of Tennessee Health Science Center, Memphis; an associate Faculty at Tufts University School of Dental Medicine, Boston; an adjunct associate faculty of the department of comprehensive dentistry at University of Texas Health Science Center Dental School, San Antonio; and an adjunct professor in department of restorative dentistry at Loma Linda University, Loma Linda, Calif. He has a private practice in Tulsa, Okla. He can be reached via e-mail at the address joe@joemassad.com.

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**Dr. Ahuja** is an adjunct assistant professor in the department of prosthodontics at University of Tennessee Health Science Center, Memphis. She is a prosthodontic consultant for Lutheran Medical Center, NY. She is also a consultant for 2 private dental clinics in Mumbai, India. She has published several articles in peer-reviewed journals including 2 book chapters. She is an editorial board member for *International Journal of Experimental Dental Sciences* and reviewer for many journals. She has been invited to present lectures internationally. Her topics of interest are implant overdentures, hybrid restorations, restorative space in implant overdentures, and CBCT in dental practice. She can be reached via e-mail at the address sahuja@uthsc.edu.

Disclosure: Dr. Ahuja reports no disclosures.

**Dr. Verma** is director-principal of Maulana Azad Institute of Dental Sciences (MAIDS), New Delhi, India, a premier dental institute of the country. He is also a vice president of the Dental Council of India and president-elect of the national Indian Dental Association. He is president of the Indian Academy of Restorative Dentistry (IARD) and honorary advisor to Armed Forces Dental Services, Ministry of Defence. He is also International Advisor of Royal College of Physicians and Surgeons of Glasgow (UK). He is an executive editor of the *Journal of International College of Dentists* (India and Sri Lanka section) and is also on the editorial boards of numerous scientific national and international dental journals. He can be reached via e-mail at the address dpmaids@gmail.com.

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**INTRODUCTION**

Treatment options available for edentulous patients include complete dentures, implant-supported overdentures, and implant-supported fixed restorations.\(^1\)-\(^3\) Reported success and survival of dental implants have made them an integral part of most modern dental practices.\(^4\)-\(^6\) Implants have helped improve the denture bearing foundation and quality of life of edentulous patients through improved prosthodontic service.\(^7\)-\(^14\)

Fixed-implant restorations offer improved stability and are nonretrievable (they stay fixed in the mouth), which makes them plausible for most patients.\(^15\) Fixed restorations are not indicated in all patients.\(^2\),\(^16\) Patients with poor oral hygiene, severe resorption of the soft/hard tissues and/or those who require lip support are best treated with implant-supported removable restorations.\(^17\)-\(^21\) Heydecke et al\(^22\) performed a within-patient crossover study, providing each patient with fixed and removable maxillary restorations. The results of the study indicated that removable maxillary implant restorations provided better function and were easier to clean than fixed implant restorations.\(^22\) A similar study done by Feine et al\(^23\) compared a bar-supported overdenture (removable) on the mandible with fixed-implant prostheses. The authors\(^23\) reported that one half of the patients chose the removable design for reasons related to ease of cleaning and aesthetics.
Removable implant restorations (implant overdentures) may be supported and retained by individual abutment-based attachments, also called stud attachments (ball, magnets, resilient stud attachments such as Locators [Zest Anchors], ERA [Sterngold]), and nonresilient stud attachments (such as Ankylos Syncone [DENTSPLY International]), or through bar-and-clip attachment systems. 24-28

It is critical to consider the restorative and aesthetic space before choosing an attachment system.28,29 For implant overdenture patients, the restorative space must accommodate a denture base of sufficient dimensions, appropriately positioned denture teeth, and an implant attachment system.30 When an abundance of vertical restorative space is available, the complete range of overdenture attachment systems may be considered (such as bar-and-clip attachments, and stud-type attachments).31 Attachment selection, aesthetic and functional denture tooth positioning, denture base contour, and structural durability of the overdenture become significant concerns in patients with inadequate restorative and aesthetic space.30-32 In these patients, it is critical to the success of long-term dental implant rehabilitation that thorough diagnostic procedures identify this lack of restorative space prior to surgical implant placement and selection/fabrication (bar) of attachments.29,30,32 Overdenture reinforcement to maintain physiologically acceptable denture base contours, while improving resistance to fracture, is indicated in patients with inadequate restorative space.31,33

A report on maxillary implant overdentures suggested that a minimum of 13.0 to 14.0 mm of vertical space was required for bar-supported overdentures and 10.0 to 12.0 mm for individual attachment-supported overdentures.34 Failure to carefully plan bar attachment systems may render the final prosthesis poorly contoured and/or substantially weak due to thin denture base segments and significantly reduced denture teeth.31 An appropriate attachment system for the patient should be selected based on multiple factors that must be identified early in the treatment sequence.28,31

Patient satisfaction with implant-supported overdentures is dependent on several factors including the degree of retention, restorative component fit, use of attachment elements, and proper denture fabrication.35

It is important to note that each and every step in the fabrication process is critical to the construction of successful restorations. If an error is noticed in any one step, it should not be carried forward to the next step; errors get multiplied in every subsequent step and will become nonrectifiable in the final step.

This article will discuss the procedure and protocol of the clinical and laboratory steps for the fabrication of implant overdentures with consideration of the aesthetic and restorative space.

**CASE REPORT**

**Diagnosis and Treatment Planning**

A 42-year-old white male patient with a debilitated dentition was treatment planned for implant-supported overdentures. The patient had a collapsed vertical dimension of occlusion (VDO) with insufficient restorative and aesthetic space in both arches. The patient demonstrated poor oral hygiene and had financial constraints.

Procedures to increase the restorative space would have to be employed to fabricate a functional, aesthetic, and structurally resistant prosthesis for the patient. The restorative space needed for the maxillary arch would be achieved by increasing the existing reduced VDO.31,36,37 Alveoloplasty was indicated for the mandibular arch (spanning from first bicuspid to first bicuspid region) to gain the needed restorative space.31,36 Both these procedures would help gain sufficient restorative space for fabrication of removable implant restorations supported by individual attachments.

**Extractions and Implants Done by the Oral Surgeon**

Following full-mouth extraction and alveoloplasty in the lower jaw, 6 maxillary and 4 mandibular single-stage implants (Tapered Screw-Vent Implant System [Zimmer Dental]) were planned and placed in the maxilla and the mandible, respectively (Figure 1), based on the design of the definitive prosthesis. In addition, 2 small-diameter implants (SDIs) (ERA mini dental implant system [Sterngold]) were placed in the mandibular arch to support and retain the transitional mandibular prostheses. Immediate transitional removable restorations were adjusted and delivered to the patient. The implants and tissues were allowed to heal for 6 months. The
Our patient was recalled regularly and was pleased with his restorations. He approached the clinic for the fabrication of definitive restorations 6 months after placement of implants.

Our patient was treatment planned to receive maxillary and mandibular removable implant overdentures supported by individual attachments. Since he had limited restorative space, metal frameworks would be incorporated in the dentures. \(^{35,38-42}\) New impressions and records were taken for this patient to further improve the VDO (to gain restorative space) and also to take the improved muscle tone into consideration. The definitive prostheses were fabricated following current best practices and procedures, as described below.

**First Clinical Appointment: Definitive Impressions**

The maxillary and mandibular master impressions were made in the first appointment using clear thermoplastic impression trays (Strong-Massad Denplant Low Temp Tray [Nobilium]) and varying (compatible) viscosities of vinyl polysiloxane (VPS) impression material. \(^{43-45}\) The same technique was used for making both maxillary and mandibular definitive impressions.

The healing abutments were removed, and open-tray impression copings (Zimmer Dental) were attached to the implants. Then, a panoramic radiograph was taken to ensure the seating of the impression copings (Figure 2). An impression tray was selected such that there was 2.0 to 4.0 mm space between the tray and denture bearing tissues, vestibule, and impression copings. (This was done to ensure enough thickness of impression material around both sides of the coping.) The clear impression tray helped in visualizing the impression copings and the space between the impression copings and the tray. The tray was inserted in a heated water bath and, once a rubbery consistency was obtained, it was placed in the patient’s mouth. The patient was then asked to pucker his lips, smile, swallow, and perform various mandibular movements (open and close and move the jaw from side to side), helping to mold the maxillary tray according to his anatomy and physiology. Next, the impression trays were further adjusted with e-cutters (as needed), and then reshaped. The same procedures were then done for the lower tray.

Tray adhesive (Caulk Tray Adhesive [DENTSPLY Caulk]) was applied, and heavy viscosity VPS material (Aquasil Rigid [DENTSPLY Caulk]) was injected in 3 areas (anterior, right posterior, and left posterior) of the impression tray. The tray was inserted in the oral cavity and centered on the ridge to create tissue and implant stops; tissue and implant stops guided precise tray placement around implant copings, reduced rotational movement, improved tactile feedback to prevent over-seating (especially in edentulous soft-tissue areas) and provided a controlled path of reinserterion. The impression tray was then removed from the mouth after the complete polymerization of the impression material. Excess impression material was trimmed with e-cutters and/or a sharp blade. The tissue stop presented with indentations in the area of the impression copings (Figure 3a). This helped identify the exact location of the implants. Holes were created with the e-cutter in the areas of impression copings (Figure 3b) to facilitate making open-tray impressions. The tray was tried in the mouth to ensure that all the screws of the impression coping were relieved adequately.

Next, heavy viscosity VPS material (Aquasil Rigid) was injected along all the borders of the tray. The impression tray was placed in the mouth and seated completely with the aid of tissue stops. The patient was instructed to make orofacial movements such as pucker the lips, smile, cough, suck, open and close the mouth, and move the jaw from side to side to record the maxillary vestibular borders. The same procedure was then followed to record the mandibular vestibular borders. The impression tray was removed from the mouth after the complete polymerization of the
impression material and examined to assess the extension of the borders and evaluated to check if additional material should be added or relieved. Next, the height of the borders was trimmed with e-cutters by one mm to capture the vestibular details with a lighter viscosity VPS impression material (wash impression).

Lastly, 2 different viscosities (heavy and medium) of VPS were used for making the final wash impression. Medium viscosity VPS (Aquasil Monophase [DENTSPRY Caulk]) was injected around the impression copings in the mouth. The tray was loaded with heavy viscosity impression material (Aquasil Rigid) in the vicinity of implants (to prevent movement of the copings during attachment of the implant analogs and pouring of the cast) and medium viscosity VPS (Aquasil Monophase) opposite the tissue area in the remainder of the tray. The tray was completely seated with the aid of tissue stops. The patient was asked to make orofacial movements to capture the vestibular details with the wash impression. Following the complete polymerization of the impression material, the impression copings were unscrewed through the holes in the tray and the impression was removed from the oral cavity and examined for detail (Figures 3c and 3d).

The healing abutments were then attached to the implants. Appropriately sized implant analogs (Zimmer Dental) were attached to the impression copings (on the impression), and tissue-forming material (InstaGums [Sterngold]) was injected around the implant copings to generate a soft-tissue cast. Both the maxillary and the mandibular master impressions were beaded, boxed, and poured with Type IV flowable die stone (Flowstone Fast Set [Whip Mix]) to generate implant level casts.46 The viscosity of die stone allowed for a liquid pour, eliminating the need for vibration, thereby buffering the implant coping-analog assembly from the possibility of movement during the pour.

Second Clinical Appointment: Cast Verification

Inaccuracies can be introduced during making of the impression, attachment of the analogs to the impression copings, and pouring of the cast. These inaccuracies cause misfit and lead to nonpassive castings.47 Passive-fit implant prostheses can only be generated on a cast with verified
implant positions. It is recommended that one use a verification jig to ensure the correct implant positions on the cast. Verification jigs were fabricated for both the maxillary and mandibular casts. The verification jigs were fabricated in segments using nonengaging open-tray impression copings (Figure 4) and a light-cure material with minimum polymerization shrinkage (Primopattern LC gel [Primotec]). All the segments were joined, and the verification jig was tested in the mouth with one screw test (Schefield). A single distal screw was tightened, and the seating of all the other copings was noted. This process was repeated for all the implants. A panoramic radiograph was taken to verify complete seating of the verification jig. If the verification jig had not seated in the mouth (Figure 5), indicating that the cast was inaccurate, an impression would have been retaken and the cast re-verified.

**Jaw Relation Records**

Record bases (Triad [DENTSPLY Prosthetics]) were fabricated for maxillary and the mandibular cast to take jaw relation records. Access holes were created in the mandibular record base with e-cutters in the locations of the implants (Figure 6). The access holes aided with retention, prevented interference with healing abutments, and ensured complete seating of the record base in the mouth. The vertical dimension at rest (VDR) was recorded, by marking a dot on the tip of the patient’s nose and another dot on his chin. Then, the patient was asked to take a deep breath and relax; when the patient was fully relaxed, the caliper was used to record the distance between the 2 dots. This measurement represented the patient’s physiological rest position (VDR). The proper VDO would be 2.0 to 4.0 mm less than VDR depending on the patient’s physiology. An intraoral Gothic arch tracer (Nobilium) was used for recording the established VDO and centric relation (CR) (Figure 7). An interocclusal record was taken at the established VDO with the patient in CR position with a VPS bite registration paste (Regisil [DENTSPLY Caulk]). Next, a face-bow record (Figure 8) and a protrusive record (used to set the articulator’s condylar elements to achieve a balanced occlusion) was made, and the casts were mounted on a semi-adjustable articulator (Denar 330 Articulator [Whip Mix]).

**Contouring Maxillary Wax Occlusal Rim**

Another record base and a wax occlusal rim were fabricated for the maxillary cast. Using standard complete denture clinical methods for assessing aesthetics, phonetics, and biomechanical dictates of appropriate denture tooth position, the wax occlusion rim was appropriately adjusted. The adjusted wax occlusal rim served as a guide for setting the teeth accurately. Maxillary anterior teeth were set chairside and evaluated for aesthetics and phonetics at the same appointment. Preview (Nobilium) shell teeth could also be waxed to the
occlusal rims and utilized for evaluating aesthetics and phonetics.

**Neutral Zone Determination**

A record base and softened impression compound rim (similar to a wax rim) were fabricated for the mandibular cast (Figure 9a). The rim was placed in a heated water bath, and when the compound was softened throughout, it was inserted in the patient's mouth (Figure 9b). The patient was asked to swallow while drinking warm water for one minute, then was given cool water. This procedure helped the muscles mold and shape the softened compound rim, thus identifying the functional location (Neutral Zone) of the anterior and posterior teeth in buccal and lingual positions. It aided in developing appropriate tooth locations and setting the mandibular teeth in a neutral space. The record base with the compound occlusal rim was removed from the oral cavity and evaluated. Another record base and wax occlusal rim was then fabricated for the mandibular arch. Prosthetic teeth were selected and arranged on the maxillary and mandibular wax rims based on the aesthetic and functional information provided by the adjusted maxillary wax occlusal rim and mandibular compound occlusal rim.

**Third Clinical Appointment: Wax Try-In and External Impressions**

The wax trial dentures were evaluated intraorally for aesthetics, phonetics, VDO, and CR. Next, the external impressions were made to develop appropriate contours of the polished surface of the maxillary and mandibular wax trial dentures. Baseplate wax, apical to the prosthetic teeth on the wax trial denture, was carefully removed. Then, VPS tray adhesive was painted on the area where the wax was removed and low viscosity VPS impression material (Aquasil Ultra LV Fast Set [DENTSPLY Caulk]) was applied to the same area. The waxed trial denture with the impression material was inserted into the patient's mouth. The patient was then instructed to make orofacial movements such as pucker the lips, smile, cough, suck, open and close the mouth, and move the jaw from side to side to make the maxillary external

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**Figure 8.** Animation depicting face-bow record being made.

**Figures 9a and 9b.** (a) Record base with compound occlusal rim. (b) Patient performing mandibular movements to mold compound occlusal rim.

**Figure 10.** Facial matrix used to evaluate restorative space for maxillary arch.
impression. The same procedure was then followed to make the mandibular external impression. The wax trial dentures were removed from the mouth following the complete polymerization of the impression material and evaluated. Next, any excess impression material was trimmed away with scissors.

Ideally, restorative and aesthetic spaces should be evaluated in the diagnostic phase before placement of implants. Nevertheless, the restorative space must be evaluated before selecting the attachments and processing the denture. An occlusal or facial matrix (Figure 10) and/or a CBCT scan (Planmeca ProMax 3D [Planmeca]) of the patient with the wax trial denture was used for reassessing the restorative space. A lip ruler (Massad Edentulous Aesthetic Functional Space Ruler [Nobilium]) was used for assessing the aesthetic space (Figure 11). This patient had limited restorative and aesthetic space; hence, individual attachments were chosen for him. If fabrication of a bar would have been chosen for this patient (Figure 12), the occlusal aspect of bar would have been at the level of the resting lip. The occlusal plane and the VDO would have had to have been altered substantially to gain proper restorative space for the prostheses, affecting aesthetics, function, and patient comfort. Design modification of the bar would not have helped with the restorative space either (Figure 13). This would have caused frustration for the dentist and disappointment for the patient.

Appropriately sized ERA abutments were chosen for each implant and the ERA abutment assembly (ERA abutment and retentive element) was attached to the implant analogs on the casts. The casts and the wax trial dentures were sent to the laboratory for fabrication of metal frameworks.

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**Consideration of Aesthetic and Restorative Spaces**

**Figures 11a to 11c.** (a) Lip ruler used to measure maxillary aesthetic space during repose. (b) Lip ruler used to measure maxillary aesthetic space during smile. (c) Lip ruler used to measure mandibular aesthetic space during repose.

**Figures 12a and 12b.** (a) CBCT scan depicting the maxillary bar. (b) CBCT scan with the 3-D face photo reveals that occlusal aspect of bar is at the level of the resting upper lip.

**Figures 13a and 13b.** (a) CBCT scan depicting bilateral posterior maxillary bars with attachments. (b) CBCT scan with 3-D face photo reveals that the occlusal aspect of bilateral posterior maxillary bars is at the level of the resting upper lip.
Fourth Clinical Appointment: Framework Try-in
The maxillary and mandibular metal frameworks were evaluated intraorally for fit and adjusted as needed. Frameworks, wax trial dentures, and the casts were sent to the dental laboratory team for processing the dentures along with the retentive elements of the ERA abutments.

Fifth Clinical Appointment: Denture Delivery
ERA abutments were attached to the implants intraorally, then torqued per the manufacturer's recommendations. The implant-supported overdentures were adjusted as needed and then delivered to the patient (Figures 14 to 16). The patient was educated and instructed regarding the hygiene procedures and scheduled for routine maintenance visits.70

IN SUMMARY
The techniques described in this article will aid in fabrication of accurate definitive prostheses. Bars and stud attachments are the primary attachment systems available for implant-supported overdentures; however, bars may not be always indicated depending on aesthetic space, restorative space, and the oral hygiene of the patient.

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Consideration of Aesthetic and Restorative Spaces

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1. Patients with poor oral hygiene, severe resorption of the soft/hard tissues and/or those who require lip support are best treated with implant-supported removable restorations.
   a. True   b. False

2. It is not important to consider the restorative and aesthetic space before choosing an attachment system.
   a. True   b. False

3. Overdenture reinforcement to maintain physiologically acceptable denture base contours, while improving resistance to fracture, is indicated in patients with inadequate restorative space.
   a. True   b. False

4. A minimum of 13.0 to 14.0 mm of vertical space was required for bar-supported overdentures, however, only 5.0 to 7.0 mm is needed for individual attachment-supported overdentures.
   a. True   b. False

5. An appropriate attachment system for the patient should be selected based on multiple factors that must be identified early in the treatment sequence.
   a. True   b. False

6. Since the patient (presented in this case report) had limited restorative space, metal frameworks would not be required in the dentures.
   a. True   b. False

7. Passive-fit implant prostheses can only be generated on a cast with verified implant positions.
   a. True   b. False

8. Due to advances in technology, restorative and aesthetic spaces no longer need to be evaluated in the diagnostic phase before placement of implants.
   a. True   b. False

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Please check the correct box for each question below.

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