Conventional complete denture prosthetics require several appointments to register the maxillomandibular relationship and evaluate the esthetics. The fabrication of milled complete dental prostheses with digital scanning technology may decrease the number of appointments. The step-by-step method necessary to obtain impressions, maxillomandibular relation records, and anterior tooth position with an anatomic measuring device is described. The technique allows the generation of a virtual denture, which is milled to exact specifications without the use of conventional stone casts, flasking, or processing techniques. (J Prosthet Dent 2014; -

Present-day advances have led to the incorporation of computer-aided design/computer-aided manufacturing (CAD/CAM) technology into the design and fabrication of dental restorations, including complete dentures. Different systems for making impressions and fabricating casts of a patient's dental structures have been introduced, some of which also allow for the production of specific restorations in the laboratory, in the dental office, or at a centralized production center.

The information for the development of a CAD/CAM cast or restoration can be acquired extraorally from an impression or from a cast of the object or intraorally by directly recording the structures intraorally. Different systems use different tools to collect this information. Mechanical digitizing systems rely on touch probes (tactile), whereas optical digitizing systems use cone beam computed tomography, laser, or light-emitting diode scanners. These data are processed by software and then used to fabricate the desired object or restoration with the CAM portion of the system.

In 2007, Quaas et al studied the measurement uncertainty and the 3-dimensional accuracy of a mechanical digitizing system and concluded that the measurement uncertainty for the system was low and the precision was high. However, they discouraged the application of this method for the digitization of flexible impression materials because the physical contact of the probe with the soft material might lead to deformation and increased inaccuracy. In 2012, Goodacre et al proposed a technique to obtain maxillary and mandibular definitive impressions of the edentulous arches so these could be scanned and data acquired to mill denture bases with CAD/CAM technology. They also described the process for recording the neutral zone, the maxillary and mandibular anterior teeth position, the palatal morphology, the occlusal vertical dimension, and the interocclusal relation so these could be included as part of the process of fabricating the bases. Furthermore, they used a prototype of 3-dimensional software that allowed the milling of the tooth sockets in the denture base according to the desired arrangement.

The use of computer-generated dentures is changing the procedures for denture fabrication. CAD/CAM technology differs from the conventional method in that the laboratory work is simplified and fewer appointments are needed. Recently, Bidra reported the use of CAD/CAM technology for the fabrication of mandibular implant-retained overdentures in only 2 clinical appointments. This report describes a technique to fabricate a complete dental prosthesis with CAD/CAM technology. The technique presented uses a standard clinical procedure to fabricate dentures for a patient with existing dentures in only 2 appointments. The measurements were recorded at the first appointment and inserted at the second appointment.

**TECHNIQUE**

1. Make a definitive impression with the impression materials and thermoplastic moldable trays which are

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available in different sizes (AvaDent). Initially, mix the 2 part heavy-consistency polyvinyl siloxane (PVS) and press it into the existing denture to create a PVS cast.

2. Measure the residual ridge and select the appropriate thermoplastic tray. Place the tray in a hot water bath (77°C) and mold to the cast.

3. Evaluate the tray intraorally to ensure it covers all the appropriate anatomic areas and adjust the borders as needed. As with any conventional edentulous impression technique, dry the tissue with gauze. First, border the mold with heavy-body material and make the definitive impression with a regular-set light-body PVS material (Figs. 1, 2).

4. Choose the correct size anatomic measuring device (AMD) (1 of 3 available sizes) (AvaDent) by using the caliper to measure the widest part of the residual ridge (Fig. 3). If the residual ridge is between sizes, use the smaller AMD size. With the existing dentures in the mouth, assess the occlusal vertical dimension (OVD) and rest position with a preferred assessment method. Establish whether these dimensions are correct or whether they need to be altered. Once established, place dots on the patient’s facial features and record the OVD with a caliper.

5. Coat the AMD maxillary tray with the specified adhesive (Express fast set polyvinyl siloxane PVS maxillomandibular registration record; Xer-tec) material onto the tray and place intraorally to stabilize the AMD on the residual ridge before making the records. Coat the AMD mandibular tray with adhesive, express the PVS maxillomandibular relationship record material onto the tray, and place the tray in the mouth. Extend the mandibular AMD as far posteriorly as possible and place it horizontally (Fig. 4).

6. Place both AMDs into the mouth and attach the AvaDent ruler (Fig. 5). Align the ruler parallel to the interpupillary line and record the angle that will be used to correlate the completed AMD to the virtual mounting with software algorithms. With the central bearing tracing device resting on the mandibular tray, adjust the OVD by turning the fitting on the side of the AMD to raise and lower the central bearing pin (Fig. 6). Then confirm the OVD. To confirm the centric relation with a gothic arch tracing, coat the tip of the bearing pin with a marking agent, coat the mandibular tray with occlusal spray, or rub it with occlusal paper. Guide the patient’s mandible back and trace lateral, anterior, and posterior excursions on the mandibular tray with the
bearing pin. Direct the patient to “keep jaws together,” “slide lower jaw as far forward as possible,” “as far back as possible,” and “as far left and right as possible.” Create the gothic arch tracing accordingly.

7. Remove the mandibular tray and drill a divot into the tray at the tip of the arrow. Replace the tray intraorally, place the tip of the pin into the divot, and stabilize the AMD by liberally injecting maxillomandibular relationship record material into the area between the maxillary and mandibular trays (Fig. 7). Remove any record material from the maxillary AMD that might interfere with the drape of the lip. Adjust the lip support to the desired lip fullness by turning the fitting on the anterior of the lip support.

8. As a guide for selecting the appropriate denture tooth mold, overlay the esthetic transparent guide onto the existing denture. Use 1 of 3 overlay esthetic transparent guides, which represent different tooth sizes. Once the proper transparent guide is chosen, establish the desired gingival height and mark it on the prescription. Mark the midline and incisal edge for the anterior teeth on the lip support. Place composite resin (Tetric EvoFlow; Ivoclar Vivadent) onto the transparent guide and adhere this to the lip support. With the AMD in the mouth, verify the esthetics and OVD (Fig. 8).

9. Send both the completed impressions and the final AMD to the laboratory for fabrication of the dentures.

10. Examine the digital preview virtual setup sent by the laboratory, and modify the design of the denture if needed (Fig. 9).

11. Once processed, the dentures are returned to the dentist for delivery to the patient (Fig. 10).

DISCUSSION

Many materials have been used in the fabrication of denture bases. From wood to porcelain, no material has received the same attention or gained the same popularity as PMMA [poly(-methyl methacrylate)]. Although it is the most common material used today, PMMA is not without problems. These problems are related to processing, porosity, fracture strength, dimensional stability, color stability, and biocompatibility (allergic reactions). Challenges with the use of PMMA bases are being met by either improving the qualities and properties...
of the material or the use of alternative materials. The AvaDent dentures are produced by machining a pre-formed cylinder of acrylic resin material. This cylinder is produced under high pressure and heat, which prevents shrinkage of the definitive milled prosthesis. As a result of the highly condensed resin, there is a decrease in free monomer, a decrease in the porosity when compared to a conventionally processed denture, and a decrease in the retention of Candida albicans by the denture base. Manufactured acrylic resin teeth, which are not CAD/CAM produced, are used.

The fabrication in the laboratory starts with relating the scanned maxillary and mandibular impressions to the scanned AMD. The 2 files are digitally overlaid and merged by best-fit triangulation. Millions of digital triangles overlap each other to form a vertical representation of jaw position and vertical height. A virtual record base is created, and functional controls are then applied. The algorithms for the occlusal arrangement are written using traditional rules. The occlusal plane is set from the incisal edges of the mandibular teeth to halfway up the retromolar pad, and the curves of Spee and Wilson are incorporated into the software to create the optimum occlusal arrangement on the basis of the operator’s preference. Lingualized or monoplane occlusal schemes may be chosen. The designed software arranges the teeth according to the specific guidelines of the desired occlusion, with the transparency being the guide for the maxillary anterior teeth. A digital preview is sent to the dentist, who can examine the virtual setup and modify the design of the denture.

Once the design of the teeth is accepted by the clinician, the intaglio surfaces of the denture and tooth sockets are milled with a 5-axis milling machine. The sockets for the selected teeth are milled according to the position of the selected teeth. The selected teeth are chemically bonded to the AvaDent base material by means of a proprietary PMMA bonding technique that uses heat and pressure, or if requested, a clinical evaluation of the denture can be selected. The teeth are set into the milled sockets in wax and returned to the dentist for evaluation, allowing for movement of the anterior and posterior teeth, adjustment of the occlusion, and adjustment of the denture base. In the wax evaluation method, the teeth are attached to the base with conventional techniques.

Should the patient not have existing dentures, irreversible hydrocolloid impressions are made and casts are poured. The thermoplastic trays are adapted to these casts. The vertical dimension of rest is obtained by the use of phonetics, specifically the bilabial sounds. Once obtained, the OVD is calculated. The same technique is then followed as with a patient who has existing dentures.

The stability of a denture, that is the ability to “resist displacement by functional horizontal or rotational stresses,” depends to a great degree on the occlusion and base adaptation. The transfer of concentrated stresses from the denture base to the underlying supporting structures has been associated with trauma to the tissues and accelerated bone resorption. In the currently described technique, there should be reduced dimensional stability problems because the denture is milled from preformed acrylic resin. This quality should compare favorably to bases fabricated with conventional processing techniques. This may contribute to the improved stability and retention of the denture base with less trauma and fewer postinsertion adjustment visits.

The digital system facilitates the completion of dentures in 2 visits. Impressions, occlusal relation records, and an orientation record are made at the first visit and the dentures inserted at the
second. This significantly reduces the time the patient spends in the dental office. Unlike in the fabrication of conventional dentures, there is no facebow record. If the maxillomandibular record is made at the correct OVD, the lack of facebow should not cause any error. A repository of the digital record is stored, and an exact duplicate denture can be reproduced at any time. The denture can be designed according to the dentist’s specifications. Bases can be fabricated with various anatomic features, including stippling, rugae, thickness of the actual base, and borders of the dentures. A wax evaluation can also be requested. Various shades of acrylic resins are available for the fabrication of the bases, and manufactured acrylic resin teeth are used. The denture teeth are placed virtually and the bases with tooth sockets milled. The exact positions of the teeth are recorded. These tooth positions are compared to a scan made of the denture and tooth positions after the dentures have been fabricated. A virtual remount is possible, and where discrepancies are noted, the equilibration of the teeth is completed in the milling center and clinical remount procedures are avoided. A denture kit is provided with all the materials required to make the initial records and impressions. The actual scanning of records is made off-site, eliminating the need for the dentist to purchase expensive machines. Commercial laboratories can now scan impressions and design the dentures; however, all denture base milling is done at the central laboratory. Complete dentures, immediate dentures, and implant dentures can be fabricated with this system.

Although initial results are promising, the technique has some disadvantages. The central bearing tracing device can be a challenging method of recording jaw relationships. Although the recording of the gothic arch tracing in some patients may be difficult, alternative techniques are being introduced. Further, the system does not provide for all schemes of occlusion, and no long-term results have been published. Long-term clinical trials should be performed to evaluate the success of the technique presented.

SUMMARY

A technique for the fabrication of a CAD/CAM denture is described. By using an AMD, the dentist can make clinical records in 1-step appointments. The AMD allows the clinician to gather all the clinical information needed with a single intraoral device. The virtual denture is milled to exact specifications without the use of conventional stone models or flasking and processing techniques.

REFERENCES


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