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DENTAL TECHNIQUE

Functionally suitable digital removable complete dentures: A dental technique

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ABSTRACT

This article describes a technique for fabricating removable complete dentures by using digital technology which aims to produce an individually designed, diagnostic, complete denture. This technology could reduce the number of appointments compared with traditional complete denture treatment and has a wide range of applications for different types of edentulous patients, including those with severe resorption of the alveolar ridge or a high occlusal force. Furthermore, the low cost of 3D printers, compared with expensive milling machines, may make the approach more accessible. (J Prosthet Dent 2020;123:795-9)

Traditional removable complete dentures have a long history; however, limitations include the long treatment period,[1,2] a difficult procedure that depends heavily on the experience and skill of the dentist, and a definitive denture that typically requires repeated adjustment or even reworking after denture delivery.[3] Few dentists have the ability to fabricate a suitable removable complete denture, and many younger dentists are reluctant to provide complete dentures.[4]

In the recent years, digital technology has been used in a more efficient manner than traditional methods for complete dentures.[5] Commercial digital complete denture systems, such as AvaDent (Global Dental Science LLC), Dentca (Dentca Inc), and Baltic (Merz Dental GmbH), can provide the denture at the second visit (not including a clinical evaluation), which is the most expedient of the existing commercially available systems.[3] However, the 1-step impression method those systems use may not be suitable for all patients, such as for those with severe alveolar resorption. In such patients, a 2-step impression method is recommended to acquire more accurate and better border extension of the impression so as to improve retention and comfort of the denture.[6] Moreover, a clinical evaluation of the denture is highly recommended in those systems to reduce the possibility of inappropriate fit or poor esthetics, requiring another appointment visit.[7] The protocol for a milled denture base bonded to artificial teeth is widely used in commercially available complete denture systems. The advantage is the lack of polymerization shrinkage of the milled blank compared with traditional denture bases. However, it is not suitable for patients with a strong occlusal force who require a metal reinforcing baseplate in their denture or those with reduced vertical dimensions, in whom there is insufficient interalveolar space to generate the integrated teeth location hole on the denture base in the software program.[8]

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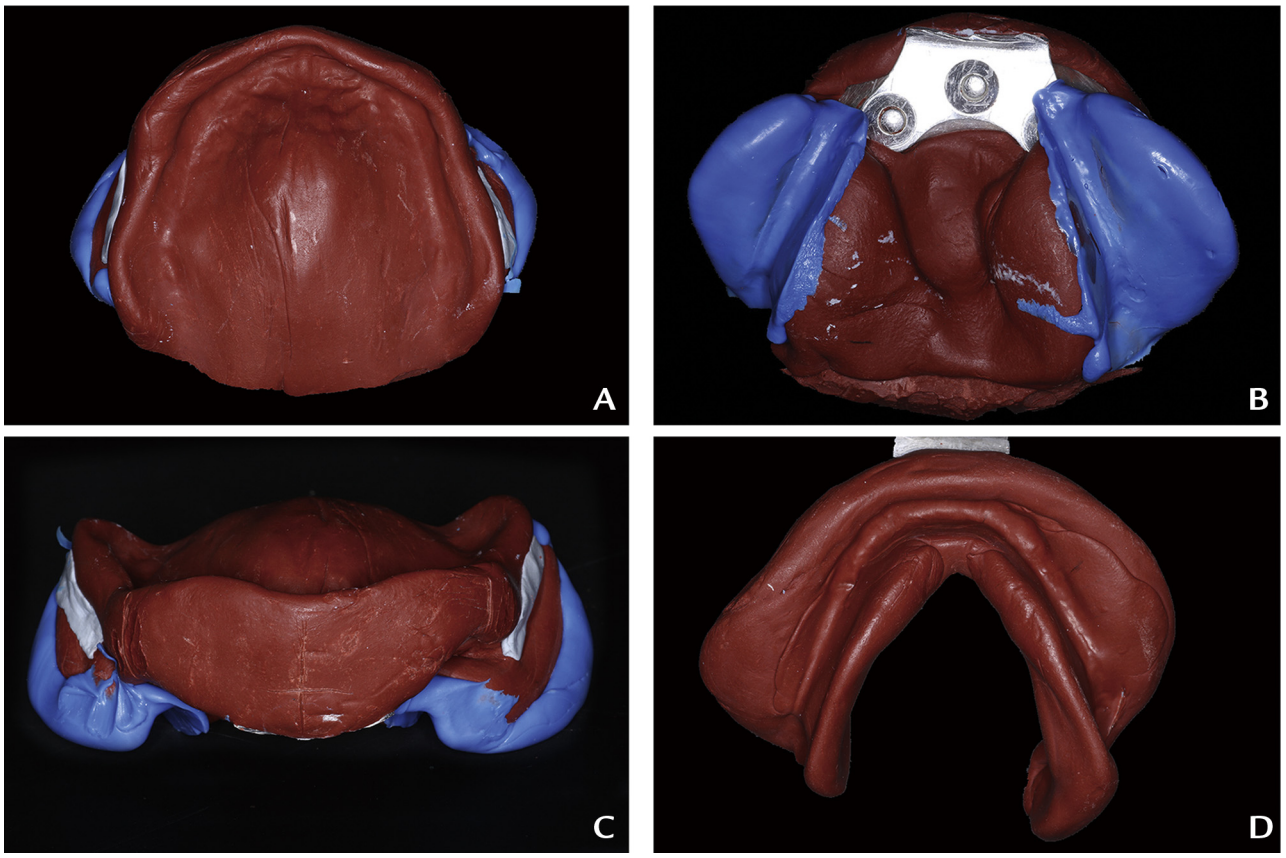

Figure 1. A, Maxillary primary impression. B, Vertical view of primary jaw relation record. C, Front view of primary jaw relation record. D, Mandibular primary impression.

Therefore, to simplify the clinical operation procedures and widen the scope of application, a functionally suitable digital complete denture (FSD) is described in this article. A diagnostic denture was designed and fabricated by using this technique to make a definitive impression to confirm the occlusal relation and esthetics so the denture can be delivered on the third visit.

TECHNIQUE

1. Select aluminum trays suitable for the patient's alveolar arch at the first visit and make primary impressions by using a modeling plastic impression compound (Red; Shanghai Rong Xiang Dental Material Co, Ltd), presoftened in approximately 70 °C water. Precut the anterior labial side of the maxillary tray and restore the lip support with impression paste (Fig. 1).
2. Draw 2 points on the nasal point and chin of the patient. Use a ruler to measure the distance between the 2 points as the rest vertical dimension and subtract 2 mm from this distance to achieve the occlusal vertical dimension. Place the maxillary aluminum tray with softened impression paste applied on the back of it into the patient's mouth. Ask the patient to occlude until the distance between the 2 points reaches the previously measured occlusal vertical dimension. Place silicone impression material (Heavy Body Regular Set; Ivoclar Vivadent AG) onto the impression paste that is on the back of the tray to record an accurate jaw relation (Fig. 1B), marking the midline, maxillary canine line, the smile line, and upper lip line position as the information for the follow-up design of the diagnostic denture (Fig. 1C).
3. Scan the primary impressions and jaw relation record on a 3D scanner (Dentscan Y500; Nanjing Geosmart3D Information Technology Co Ltd). Upload the standard tessellation language (STL) data into a complete denture design software program (Hoteamsoft Co Ltd) to design the FSD diagnostic denture (Fig. 2A). Design the margin of the denture base 2-mm inward from the margin of the impression to allow space for border molding and offsetting the tissue surface by 1 mm to contain the impression material (Fig. 2B). Design the spherical tissue stops on the intaglio of the diagnostic denture to help it seat accurately in the mouth (Fig. 2C). Then, use a 3D printer (0.8 mm diameter nozzle, Lingtong II; Beijing Sinotech Co Ltd) to print the

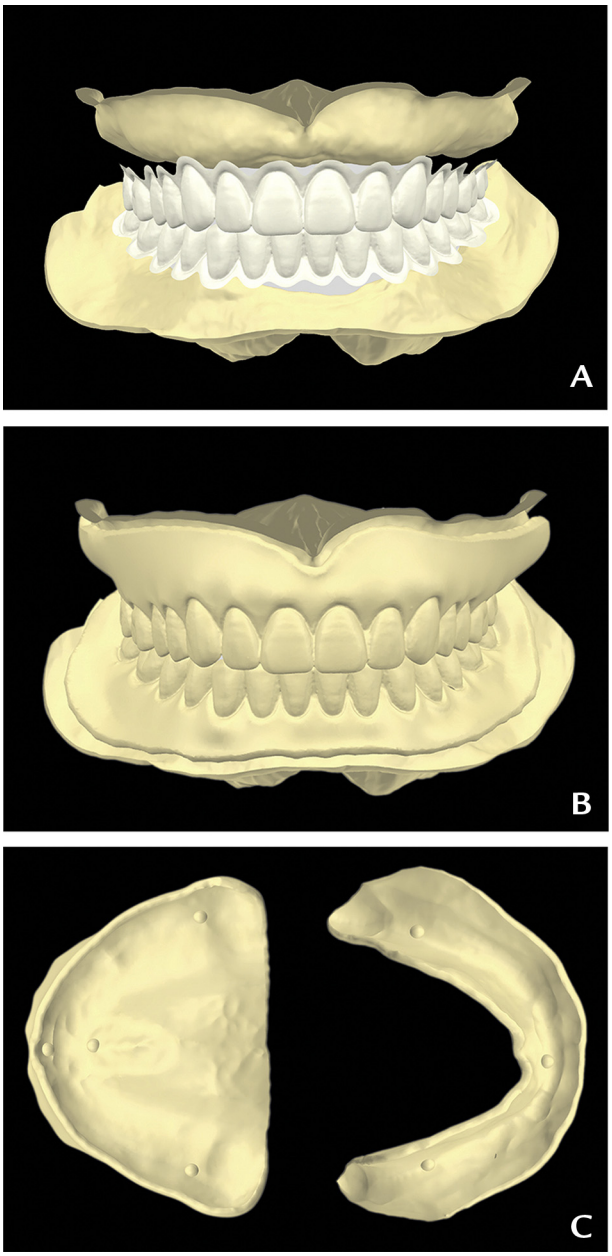

Figure 2. Computer-aided design of complete denture. A, Appropriate dentition template selected. B, Completed design. C, Tissue stops on intaglio of diagnostic denture.

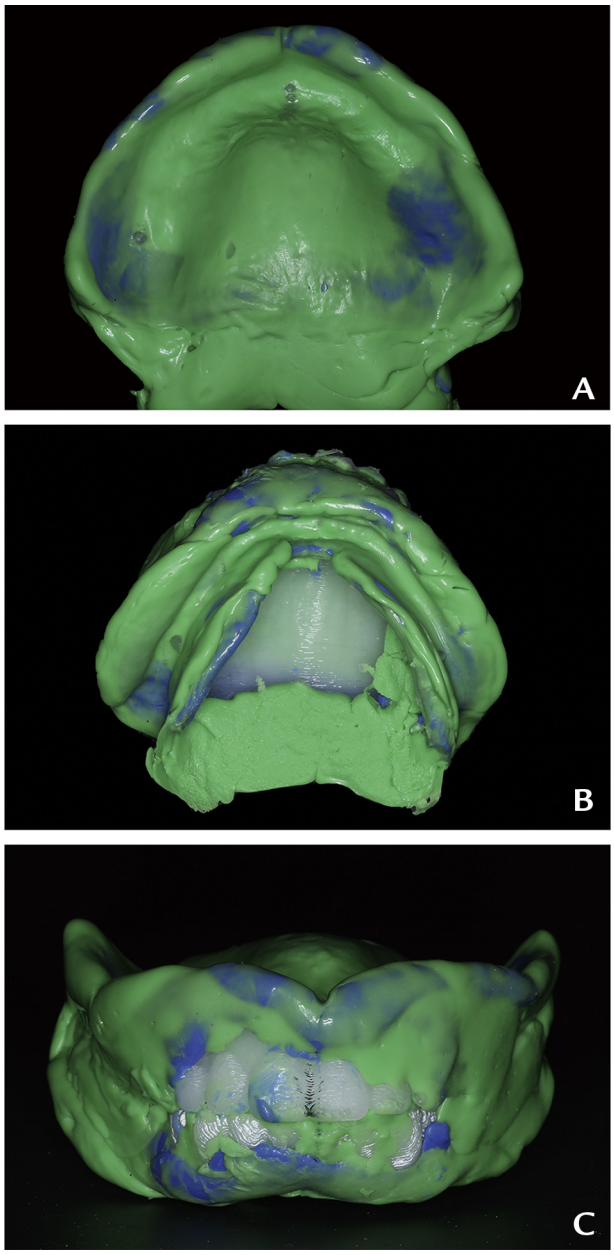

Figure 3. Diagnostic complete denture. A, B, Definitive impression of maxilla and mandible. C, Definitive jaw relation record and esthetic confirmation.

diagnostic denture by using polylactic acid (PLA; Beijing Sino tech Co Ltd).

4. Place the FSD diagnostic denture into the patient's mouth at the second visit, primary verifying the extension, jaw relation of the diagnostic denture. Add wax or shorten the dentition to adjust the vertical dimension if it is not appropriate. Examine lip support and other esthetic parameters. Use heavy-body silicone impression material (Heavy Body Regular Set; Ivoclar Vivadent AG) for functional border molding and light-body silicone (Variotime Light Flow; Kulzer GmbH) to make definitive impressions (Fig. 3A, 3B). Verify the intercuspal position stability of diagnostic denture, grinding if necessary, then record the occlusion when it is stable (Fig. 3C) using the above mentioned light-body silicone. Use the closed-mouth technique to border mold and make the definitive impression. When border molding and making impressions, the opposing diagnostic denture should be in the mouth, and the impression material polymerized with the patient in occlusion.

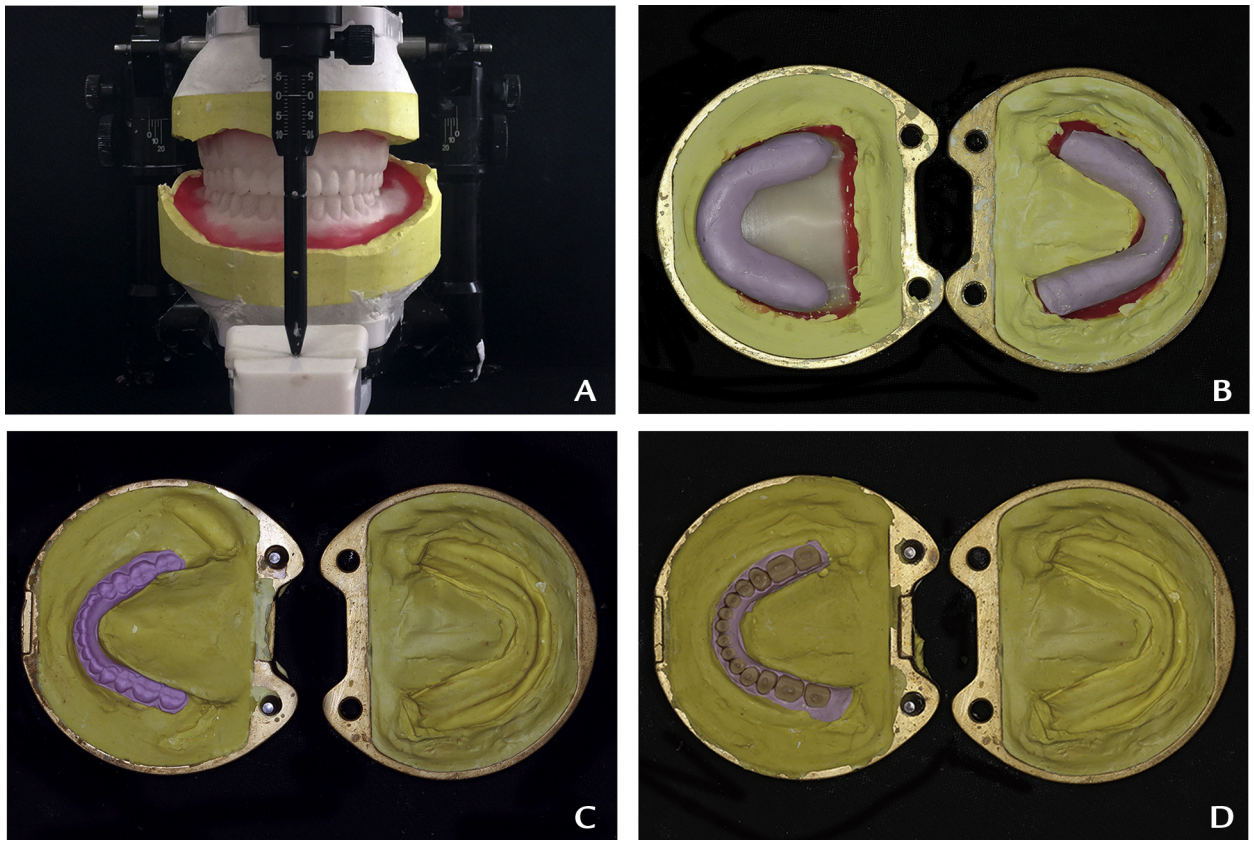

Figure 4. A, Definitive casts mounted on articulator with polylactic acid pattern located. B, Maxillary and mandibular prostheses invested with silicone impression material. C, Mandibular arch flasked. D, Artificial teeth inserted into sockets.

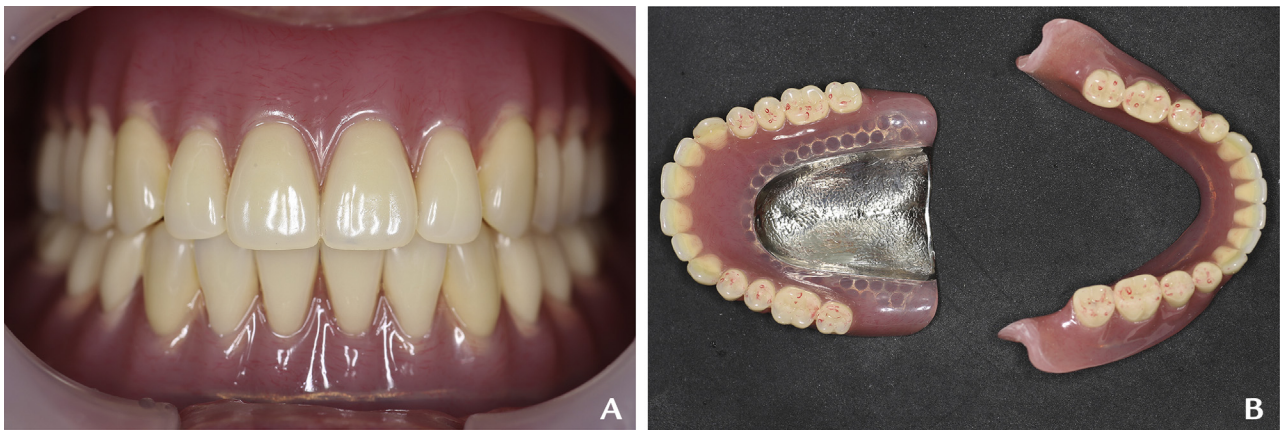

Figure 5. A, Insertion of complete denture. B, Complete denture with metal framework and baseplate.

Finally, use a marking pen to correct the esthetic information if there is any adjustment required.

5. Scan the definitive impressions and import the data into a complete denture design software program (Hoteamsoft Co Ltd) to design complete dentures. Use a highly accurate 3D printer (0.4 mm diameter nozzle, Lingtong I; Beijing Sinotech Co Ltd) to print the complete denture pattern by using PLA material. Pour gypsum casts (Die Stone; Kulzer GmbH) and mount them in an articulator (average value articulator; Basic System). Ensure the PLA denture pattern is completely seated on the casts (Fig. 4A). Wrap the dentition part with silicone impression material (Zetalabor; Zhermack Group), flask, and heat with water. After deflasking, remove the softened pattern and insert the artificial teeth of the same brand and model as in the design software program into the tooth location sockets (Fig. 4B-D).

Fill the mold with acrylic resin, heat-polymerize, deflask, adjust the occlusion by remounting the dentures on an articulator, and polish the denture.
6. Deliver the definitive complete denture at the third visit and evaluate the vertical dimension, jaw relation, retention, stability, phonetics, and esthetics (Fig. 5).

DISCUSSION

FSD technology can reduce the number of treatments for complete dentures to 3 (or 2, which requires designing and printing the diagnostic denture at chair-side). Based on a straightforward primary impression and jaw relation record, FSD diagnostic dentures similar to the definitive dentures can be designed and fabricated. They are used for the definitive impression and the jaw relation record, and can be used as an evaluation denture. Closed-mouth functional border molding is performed by using the diagnostic denture to form the margin of the impression that can record the true position of the labial and buccal flange.[9] Under a moderate occlusal force, the closed-mouth impression is similar to the surface of mucosa when food is masticated using the complete denture. As a result, the denture fabricated based on this impression has improved fit and minimal tenderness.[10] In addition, the complex jaw relation record can be transformed into a straightforward dentition relation record through the diagnostic denture. The jaw relation record obtained by the diagnostic denture is in the muscular position, the terminal position of the muscular contraction path, which is generally more suitable for edentulous patients but is not as stable as centric relation.[11] Therefore, the record should be evaluated to ensure that it is correct by repeated occlusion.

The PLA pattern was printed to fabricate a complete denture combined with the traditional laboratory process, which can replace the more complicated manual tooth arrangement. This method has a wide range of applications, and casting a metal framework or baseplate can be added during fabrication to increase the strength of dentures for patients with minimal vertical dimensions or high occlusal force (Fig. 5B). The FDM machine and PLA materials used in this protocol are significantly less expensive than a milling machine and a milled blank. Furthermore, the denture can be remounted onto an articulator to adjust the teeth while a milled denture cannot, and the rigid matching between the milled base and teeth could have errors in the position of teeth that would require additional clinical adjustment. However, polymerization shrinkage of the denture base with traditional processing cannot be avoided. Integrated 3D printing may be the future, but biosafety and strength, abrasion resistance, and esthetics of printed dentures are still to be investigated.

SUMMARY

This article describes a digital technique for the fabrication of a complete denture that can simplify the clinical process, reduce the number of patient visits, and improve the fitness of denture.

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