Using Intraoral Scanning to Capture Complete Denture Impressions, Tooth Positions, and Centric Relation Records

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Intraoral scanning was used to capture the soft tissue surfaces of both maxillary and mandibular edentulous ridges and the denture borders. Additionally, an intraoral scanner was used to digitize existing dentures with their tooth positions and base forms and a centric relation record obtained with a Gothic arch-tracing device. These scans provided all the required records for fabrication of computer-aided design/computer-assisted manufacturing of complete dentures. Int J Prosthodont 2018;31:377–381. doi: 10.11607/ijp.5741

Complete denture (CD) fabrication has traditionally involved five appointments, which results in a significant amount of chair time and associated costs. Some clinicians have been able to condense the number of appointments by combining clinical procedures. With computer-aided design and computer-assisted manufacturing (CAD/CAM) of CDs, techniques have been described that further reduce the number of appointments to as little as two.\textsuperscript{1} While this has decreased clinical chair time, the procedures involved with CD impressions have remained unchanged.

Intraoral scanning has been used with dentate patients for decades\textsuperscript{2} and was recently successfully used to fabricate a removable partial denture framework that demonstrated retention and stability.\textsuperscript{3} However, challenges have been reported with the scanning of edentulous arches. For instance, one study evaluated the use of an intraoral scanner to capture a completely edentulous model and found inaccuracies in the ability of the scanner and software to create an accurate digital scan.\textsuperscript{4} As a result, other studies have tested the use of tissue additives, such as pressure-indicating paste (PIP) and composite resin markers, to improve the ability of intraoral scanners to capture the palatal area of edentulous maxillary arches.\textsuperscript{5,6} These studies concluded that the addition of surface additives did improve the ability to capture maxillary edentulous arches.

One patient treatment report has been published that described how intraoral scanning can be used to fabricate a maxillary CD.\textsuperscript{7} However, additional reports are needed that evaluate the ability of intraoral scanners to accurately capture the mucosal morphology and denture borders of both maxillary and mandibular edentulous arches. Therefore, the purpose of this technique article is to describe how intraoral scanning was used to capture all the anatomical and occlusal records required to make a maxillary CD and mandibular implant overdenture using CAD/CAM fabrication technology.

Clinical Report

A 78-year-old male presented with a chief complaint that he wanted a new set of dentures that exactly reproduced his existing dentures, allowing him to use his existing dentures as a spare without him noticing a difference between the two sets. The patient received maxillary and mandibular CDs 15 years ago made by the second author, with the mandibular CD subsequently converted to an implant overdenture (IOD). Over the years, the junction between the porcelain denture teeth and the denture bases had become stained, and one maxillary lateral incisor was dislodged and repaired (Fig 1).

As mentioned, the patient specifically requested reproduction of the teeth irregularities—especially the mandibular anterior teeth—that helped make the dentures appear more natural (Fig 2). The patient's occlusal vertical dimension (OVD) was evaluated, and it was decided that no modifications were required. Following a thorough discussion of the treatment options, the patient elected to have a new maxillary CD and mandibular IOD fabricated.

Technical Description

During the first appointment, an intraoral evaluation of the patient's edentulous arches was completed along with marking of the posterior extension of the maxillary denture using Dr Thompson's Color Transfer Applicators (Fig 3). Using an intraoral scanner (Trios 3,
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3Shape A/G), maxillary and mandibular arches were scanned to obtain digital impressions while approximating the denture borders and frenum attachments by gently grasping the lip/cheek between the index finger and thumb (Fig 4). Special care was taken to retract the soft tissues to positions that simulated the border extensions of a CD while avoiding excessive stretching. The pathway used to scan the edentulous maxilla started with the crest of the ridge, then extended to cover the palatal area, and finally captured the buccal and labial vestibules (Fig 5a). Scanning the mandible started with the crest of the ridge, then extended to the vestibules, and finally covered the lingual border extensions (Fig 5b). When scanning the vestibules it is important to capture the entire buccal and labial vestibules in one pass, as returning later to recapture a missed area will result in a different position of the reflected soft tissue, leading to an error in the digital impression. The intraorally scanned maxillary and mandibular impressions are shown with and without color (Figs 6a to 6d).

Using a Gothic arch-tracing device (AMD AvaDent, Global Dental Science), a centric relation (CR) record was made (Fig 7). The CR record was then scanned using the same intraoral scanner (Fig 8). In addition, the patient’s existing denture was scanned using the intraoral scanner so the existing tooth positions and base forms could be recorded for use in designing the new CAD/CAM-fabricated dentures. The intraorally scanned maxillary and mandibular impressions, CR record, and existing dentures were saved in a standard tessellation language (STL) file format and digitally sent to Global Dental Science for the fabrication of maxillary and mandibular trial dentures.

Using the digitally scanned CR record from the Gothic arch tracing, the maxillary and mandibular impressions were digitally articulated in CR at the desired OVD (Fig 9). The scan of the patient’s existing dentures was used to create a digital tooth arrangement that ensured the tooth positions matched those present in the existing dentures (Fig 10). A CAD/CAM esthetic try-in was requested (BTI AvaDent, Global Dental Science) to evaluate the denture’s retention, occlusion, and esthetics (Fig 11).

At the second appointment, the retention, occlusion, and esthetics of the trial dentures were evaluated, and only a minor adjustment was made to the cusp length of both maxillary canines (Fig 12). The maxillary esthetic try-in was then scanned and digitally sent back to Global Dental Science for the fabrication of the definitive fully milled monolithic maxillary CD and mandibular IOD (Fig 13).

During the third appointment, the definitive dentures were placed and minor adjustments made to the intaglio surface of the maxillary and
mandibular prostheses using PIP. A clinical remount was performed, minor occlusal adjustments made, and two Locator attachments (Zest Anchors LLC) picked up in the mandibular denture. The patient was pleased with the retention, stability, and esthetics of his new dentures (Fig 14).

**Discussion**

Intraoral scanning can be used to capture both the mucosal morphology and border extensions of an edentulous patient, and the resulting digital data used to fabricate CAD/CAM CDs. This technique offers multiple benefits, allowing the patient appointments to be condensed, eliminating the need for custom trays and conventional impression materials, and preventing the need to physically ship records to a dental laboratory, thereby reducing the overall time required to receive the final prostheses. In the example shown above, the treatment involved three short appointments that included an esthetic try-in at the second appointment. The minimal adjustments needed at the second appointment demonstrated that when existing dentures are esthetically appropriate, they can be scanned and used as a guide in the desired tooth positions, and the definitive dentures could be fabricated and placed in as few as two appointments. Otherwise, three appointments are used, as in this patient treatment with the use of an esthetic try-in to validate the retention, occlusion, and esthetics prior to the definitive denture fabrication.

The amount of time required to scan edentulous arches is of interest, as it can result in less time while eliminating the inconvenience to the patient when they have to sit for several minutes while the impression material hardens. In this patient treatment, 2 minutes were required to scan the maxilla and 5 minutes to scan the mandible. With experience and future improvements in scanners, the time involved with scanning could decrease.
However, the mandible is more difficult to intraorally scan than the maxilla and may not be scannable in all patients. In a previous patient treated by the authors, it was only possible to scan the labial and buccal borders along with the ridge crest and a portion of the lingual extension. The resulting scan with deficient lingual borders was then used to order a milled trial denture (AvaDent WTI, Global Dental Science) that was used to make a conventional reline impression that established the desired lingual borders. The authors judged the process of making a reline impression inside the milled trial denture to be easier than making a conventional mandibular impression.

Additional benefits with this technique include the ability of the intraoral scanner to capture the tissue in a true mucostatic state.3 This can be beneficial for patients with mobile tissue, where a mucostatic impression is suggested.8 Previous techniques have been suggested to reduce the amount of force placed on the soft tissue,9–11 but these techniques still place some force on the mobile tissue. Therefore, the ability of the soft tissue to be recorded in a true mucostatic state should not be overlooked, as this could provide many additional benefits. Another benefit is the use of intraoral scanners on patients with increased gag reflex8 or limited mouth opening.12 A previous article discussed a limitation with the large size of the intraoral scanner tip on the labial and buccal borders along with the ridge crest and a portion of the lingual extension. The authors judged the process of making a reline impression inside the milled trial denture to be easier than making a conventional mandibular impression.

The ability of many intraoral scanners to not only capture the mucosal morphology but also provide color images allows the posterior extensions of the maxillary denture to be marked and transferred to the final prosthesis. While the color information is lost when the scan is exported as an STL file and sent to the lab, a screenshot of the intaglio surface is taken and used to transfer the position to the digital denture. The position can then be verified or modified as needed at the trial denture appointment. Additionally, using the intraoral scanner to capture other records, such as the CR record and the patient’s existing dentures, allows more information to be digitized and sent to the laboratory. This information can greatly benefit the ability of laboratory technicians to fabricate a denture that will require minimal adjustments.

While this technique demonstrated the ability to intraorally scan both the maxillary and mandibular mucosal morphology, the process does have technique sensitivity. For instance, the presence of a minimal amount of attached mucosa can negatively affect the ability of the scanner to stitch the surfaces together, as movement of the soft tissue will occur during scanning, making it more difficult to obtain a complete scan in one pass of the scanner tip over the mucosa. To optimize the potential of obtaining a complete scan of edentulous arches, it is important that the scanner be able to stitch together a series of multiple images; therefore, specific scanning pathways have been suggested to allow the software to accurately stitch the captured surfaces together to create a full maxillary and mandibular impression. These pathways are only suggestions, as there is no consensus on the most accurate pathway.

It is important to remember that this is a new application for intraoral scanning that needs further evaluation to validate its accuracy and reproducibility, since no clinical studies to date have evaluated the accuracy of edentulous intraorally scanned impressions. However, any inaccuracies that may be incorporated in the scanning of this patient were not found to affect the retention or stability of the dentures fabricated.

A concern that will be expressed by some clinicians is the perceiving inability to accurately record denture borders. However, using fingers to gently stretch the soft tissue borders and create the roll of soft tissue and frenum attachments proved to be successful and allowed an acceptable approximation of the denture borders.
with a good peripheral seal. In fact, if multiple clinicians were to make conventional impressions of the same edentulous patient using their preferred border molding and impression procedures, there would be variations in the border extensions. Therefore, it is proposed that using fingers to stretch the mucosa and then scan the reflected tissue is yet another means of establishing a peripheral seal. It is important to note that not all patients can be successfully treated with intraoral scanning, and careful patient selection is required to ensure patients have adequate ridge height and attached mucosa to allow the required manipulation.

When determining the lingual border extensions of mandibular impressions, the most difficult area is the mylohyoid and retromylohyoid areas. This extension can be determined clinically by using a mouth mirror to displace the tongue and scan the lingual area. A measurement can even be made and transferred to the desired depth of the lingual extension, similar to the procedure used to determine the lateral throat form as described by Neil in 1932.16

Another area of concern with CAD/CAM-fabricated CDs is the ability to digitally create a bilaterally balanced occlusion. Multiple articles have discussed the use of virtual articulators and the required data that must be uploaded into software, as well as additional ways to track mandibular movements.15–17 When these processes are not possible, measurements are made clinically and manually uploaded into the software.16,17 However, the technique of transferring edentulous jaw movements to virtual articulators has not been established. In addition, the positioning of edentulous digital casts in relation to the condyles has not been refined for virtual articulators. Therefore, it is important to note that the use of virtual articulators to fabricate CAD/CAM CDs has not been actualized; therefore, a clinical remount will be required to develop a fully balanced occlusion.

Intraoral scanning of edentulous patients is in its infancy and needs further studies to compare the accuracy of intraorally scanned denture impressions to conventional border-molded impressions to determine their differences. Also, other intraoral scanners need to be evaluated, since only one intraoral scanner was used in this report. Additionally, manufacturers need to focus more research on the development of scanning that can improve the capturing of soft tissues when no teeth are present.

Conclusions

A technique that used intraoral scanning to capture CD impressions has been described. It was determined that a maxillary CD and mandibular IOD can be successfully fabricated from digital impressions made using an intraoral scanner. A benefit of intraoral scanning is the ability to capture a true mucostatic impression, which resulted in good mucosal adaptation and stability of the CAD/CAM-milled prostheses. In addition, it was possible to use the intraoral scanner to digitally record a traditional CR record as well as scan the existing dentures, thereby providing completely digitized records for the fabrication of prostheses that replicated the tooth positions and base morphology of the existing dentures as desired by the patient. This process streamlined the clinical procedures and eliminated the need to transport conventional records to the dental laboratory.

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References