A Technique for Digital Impression and Bite Registration for a Single Edentulous Arch

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Abstract
Few studies have reported the application of digital technology for the process of impression and interocclusal recordings in edentulous patients. This article describes a digitizing system for generating digital edentulous models with a jaw relationship by taking direct digital impressions and a virtual bite registration using intraoral digital scanning. A specialized scan retractor was used to make digital impressions of edentulous jaws in patients’ mouths using an intraoral scanner. Virtual bite registration was obtained with optical scanning of the buccal surfaces of both jaws at the occlusal vertical dimension. The registration was then used as a reference for aligning both jaws. Digital edentulous models that include the jaw relationship would be clinically beneficial for the fabrication of complete dentures in edentulous patients.

Conventional prosthodontic treatments and laboratory techniques have been conducted by indirect methods using various impression materials for more than 400 years. Conventional prosthodontic procedures involve many steps with the possibility for errors at any stage. Errors can occur while taking impressions, obtaining interocclusal records, or transferring models to an articulator. Although the errors can be minimized using careful techniques and control of the materials, errors cannot be completely eliminated because of the inherent properties of the impression materials that are used in the procedure or human error. Conventional prosthodontic procedures also require many visits, even if attempts have been made to reduce their number.

Recently, with the introduction of new intraoral scanner systems, intraoral digital impressions allow clinicians to directly acquire data from the mouth without the need to take a conventional impression and pour a cast. Intraoral digital scanners have the ability to obtain image information for a full dental arch scan with the same accuracy as conventional impressions. Therefore, the steps needed for fabrication are reduced, and potential errors, such as expansion, shrinkage, and distortion of impression materials and/or the gypsum master model, are eliminated or minimized; however, few studies have been published regarding the application of digital technology for taking impressions and interocclusal records in edentulous patients. Edentulous jaws represent a mucosa-based clinical situation involving several mobile zones (areas of the oral vestibule) and smooth-surface textures covered entirely by saliva. These factors are challenging with regard to direct digital impressions. Our previous works suggested that direct digital impressions of edentulous jaws could be obtained using a specialized scan retractor. The purpose of this article was to introduce a digitizing system for generating digital edentulous models with jaw relationships by taking direct digital impressions and virtual bite registrations in patients’ mouths using an intraoral scanner.

Technique
The patient described in this article has a maxillary edentulous arch and a mandibular implant-supported overdenture (Fig 1).

1. To make digital intraoral impressions of the maxillary edentulous jaw, a specialized scan retractor was fabricated (DIO Implant Co., Busan, Republic of Korea) with a universal size (Fig 2). It has a frame constructed of aluminum wire with a connected handle flexible enough to permit the shape change necessary for the frame to fit
into the vestibular area. The frame thickness should be sufficient to provide retractor rigidity, but should not be excessive. The shape of the frame on both posterior sides is flat, allowing for the application of the frame beyond the distal end of the alveolar process. The handle extends vertically from the frame in the canine region and turns anteriorly to pass over the lip with minimal interference with the oral musculature. The handle, which is located in the canine region, allows the scan head to move from the anterior to the posterior alveolar ridge segments without interference.
2. Prior to intraoral scanning, adapt the scan retractor intraorally to fit the contour of the maxillary edentulous arch by bending the frame. Extend the frame as far as possible buccally to scan the labial or buccal surface of the edentulous ridge.

3. After the scan retractor has been contoured, acquire intraoral digital impressions using an intraoral scanner (TRIOS; 3Shape A/S, Copenhagen, Denmark). First, clean the edentulous ridge and completely eliminate the presence of saliva. Position the scan retractor on the maxillary edentulous jaw so that the frame will push the vestibule down further, exposing the edentulous ridge to capture the greatest amount of surface area of the vestibule (Fig 3). Perform scanning by retracting the lip and cheek with the scanner head itself while stretching and fixing the vestibular area with the metal frame of the retractor. First, scan one-third of the upper jaw on the left side, starting at the distobuccal area, moving the scanner head in a slow zigzag toward the anterior area, and returning to the soft palatal areas. Second, scan another third of the upper jaw in the middle, starting at the soft palatal areas, moving the scanner head in a slow zigzag toward the anterior areas, and returning to the soft palatal areas. Finally, scan the remaining one-third of the upper jaw, starting at the soft palatal areas, moving the scanner head in a slow zigzag toward the anterior areas following the palatal side of the ridge and returning to the distobuccal areas on the right side (Fig 4).

4. Scan the denture teeth of the existing overdenture in the mandibular arch while moving the scanner head in a zigzag manner, starting at the distal area of one side and following the jaw crest to the opposite side (Fig 5).

5. To record the jaw relationship, establish the occlusal vertical dimension (OVD) using bimanual manipulation of the mandible and place marks on the tip of the patient’s nose and on the anterior prominence of the chin. Create interocclusal records at the OVD using putty (Fresh; Dreve Dentamid GmbH, Unna, Germany). First, use heavy-body putty to fabricate a record base for the patient’s maxillary edentulous arch. The material should be seated and adapted intraorally to fit the contours of the arch. After placing light-body putty over the heavy-body putty base, reseat the record base on the maxillary edentulous arch. Inject a vinylpolysiloxane interocclusal record material (EXABITE II NDS Bite Registration Creme; GC America, Inc., Alsip, IL) into the area between the record base and the occlusal surfaces of the mandibular teeth, then guide the patient’s mandible to the OVD where it should be stabilized until the interocclusal record material is completely polymerized (Fig 6).

6. Remove the interocclusal record from the mouth and cut out its anterior part between the first premolar sites.
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Return the remaining part to the mouth (Fig 7). The record is used to create an occlusal stop to hold the desired OVD.

7. On the anterior side where the interocclusal record is absent, record the bite registration with optical scanning of the labial surfaces of the maxillary edentulous ridge and the opposing teeth in the patient’s mouth using an intraoral scanner, while maintaining both jaws at the OVD (Fig 8).

8. Virtually align the scanned maxillary edentulous jaw and mandibular teeth images using the bite registration as a reference. The digital recording of the maxillary edentulous jaw relationship with the opposing teeth is now complete (Fig 9).

Discussion

Very few reports have been published regarding the application of digital technology for the process of impression and interocclusal recording in edentulous patients. When using digital technology for the process of interocclusal recording, a common technique included additionally scanning an interocclusal record whose negative could then be used to correctly align both arches.9-12 Interocclusal records, due to their dimension and elasticity, were bound to introduce errors when used to align the maxilla and mandible.10,13,14 In addition, the technique required a second appointment for obtaining interocclusal records, as edentulous patients who had no occlusal contact points of natural teeth required the fabrication of resin or wax record bases for stable interocclusal records.15,16 Any attempt to reduce the number of visits and chair time reduces overhead expenses and is appreciated by patients. This consideration prompted us to refrain from using resin or wax record bases for interocclusal registrations. This article described virtual bite registration that was performed with the optical scanning of labial surfaces of the maxillary edentulous ridge and the opposing teeth in the patient’s mouth using an intraoral scanner, while maintaining both jaws at the OVD with putty impression material. In the procedure, the putty impression material was used to create an occlusal stop to hold the desired OVD. The bite scan images obtained were then used as a reference in aligning both jaws to generate a 3D virtual bimaxillary model.

This article described a specialized scan retractor to make direct digital impressions of edentulous jaws using an intraoral scanner. The key factors involved in the failure to acquire direct digital impressions of edentulous jaws using intraoral scanners are mucosa properties. The mucosa, especially in the vestibular area, exhibits high displacement, which makes the border difficult to determine. Another factor may be that the mobile tissue of the lips, cheeks, and tongue moves constantly while taking a digital impression. Unlike conventional impression techniques, intraoral scanning cannot be performed while the mobile tissue is moving.17 The main advantage of the scan retractor described in this article is that it can be bent to fit the contour of the maxillary edentulous arch, an ability necessary for it to adapt well to the vestibule. Moreover, it facilitates stretching and fixation of the vestibular area, which is important to set the border of the impression. A further advantage of the retractor is that it helps retract the lips and cheeks. The quality of digital impression images obtained in this instance was good enough to determine the denture outline and anatomical landmarks such as the hamular notch, incisive papilla, and mucogingival junction. Thus, the digitalization process for edentulous jaws has been simplified, as the scan retractor allows clinicians to directly acquire data from the mouth. The digital edentulous models with a jaw relationship would be clinically beneficial for the fabrication of complete dentures in edentulous patients (Fig 10).

The digital impression technique using the scan retractor also has disadvantages, however. The vestibule can be overextended/stretched with the scan retractor. Recording the vestibule in an overextended/stretched position will lead to denture periphery overextension and a lack of retention for the denture. Therefore, chairside adjustments and a reline procedure may be necessary. A further advantage of the digital impression technique is that when the border seal of the denture is deficient, the denture can be used as a custom tray for border molding and the definitive impression. The digital images of the denture base obtained by scanning the definitive impression can be used to fabricate a new denture. Therefore, the fabrication of new dentures is simplified, as the digital workflow allows dentists to acquire the necessary data easily.

We are also interested in the use of this technique for the mandible, but that was not included in this article. Further studies involving another specialized scan retractor for making direct digital impressions of edentulous mandibular jaws are planned. For the mandibular arch, it should have a lingual frame that can be extended deep into the lingual vestibule to enable fixation of the lingual vestibule and retract the tongue as well.

Summary

This article described a method for direct digital impression taking and virtual bite registration using intraoral digital scanning to create a digital edentulous model having a jaw relationship without the need to take a conventional impression and pour a cast. The method suggests the use of intraoral optical scanning to capture the detailed morphology of edentulous jaws and align both jaws into the appropriate maxillomandibular relationship. The method and the edentulous models created may serve as the foundation for the fabrication of complete dentures in edentulous patients.

References