DENTAL TECHNIQUE

Obtaining reliable intraoral digital impressions for an implant-supported complete-arch prosthesis: A dental technique

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Supported by Country Council of Gipuzkoa grant 84/17, 2017.

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Acknowledgments

The authors thank Dr Javier Etxaniz from Trento dental clinic and the Odontolan Otaduy dental laboratory for their support and assistance with the research work.

ABSTRACT

This article describes a technique for obtaining an accurate complete-arch digital impression for an edentulous patient. To achieve this, an auxiliary polymeric device that simulates a denture is designed, fabricated, and placed in the mouth. This device, having the geometry of a typical dental arch, facilitates the digitalization of the edentulous complete arch. This is because the change in radius of the curvature (change of geometry) enables the scanner to perform a more accurate alignment. Initially, the necessary location of the implants is acquired, and then the soft tissue is added.

This technique can achieve accurate complete-arch digital impressions. The distances between implants are closer to the gold standard when using this auxiliary geometry piece than those obtained without using it.

INTRODUCTION

The use of computer-aided design and computer-aided manufacturing (CAD-CAM) technologies in dentistry has continued to grow. Among many other applications, one of the most developed has been replacing conventional dental impressions with digital impressions.[1,2] For implant dentistry, the clinical validity of the digital impression is determined by the passive fit between the superstructure and the implants.[3] However, an acceptable misfit value is yet to be determined.[4] Excessive misfit may lead to mechanical failures or biological complications.[5,6]

The trueness and precision of intraoral scanners have been evaluated.[7-18] However, accuracy is still a problem, particularly for complete-arch impressions, as the acquisition of larger areas with an intraoral scanner is more challenging.[19] One difficulty is in joining the multiple captures obtained with the cameras of the intraoral scanners.[20] With the standard method or with stereophotogrammetry, the impressions are obtained in a single step, although for devices using stereophotogrammetry it is necessary to later make an image of the soft tissues. However, with intraoral scanners, the impression process involves multiple captures over time, the number of which increases with the area to be restored. The scanner software creates the 3-dimensional (3D) impression by aligning the different captured images. In each alignment an error occurs, and the more alignments there are, the greater the accumulated error. In addition, these alignments are more complicated in situations where the geometry has no change in radius of curvature, such as the spaces between implants in edentulous patients.[17,21,22] The scanner requires an irregular shape with no repetitive adjacent surface structures for an accurate digital impression. This is why obtaining the complete-arch digital impression of an edentulous patient is challenging.

A system using stereophotogrammetry technology (PIC Camera; PIC DENTAL) seeks to overcome this challenge by using an extraoral camera. This camera provides a standard tessellation language (STL) file where targets (PIC Abutments; PIC DENTAL) placed on the implants, are highly accurately positioned. By complementing this STL file with a dental digital impression, a highly accurate complete-arch impression is achieved.[4,23] The dental digital impression can be obtained with an intraoral scanner or by digitalizing a gypsum cast with a laboratory scanner.

The objective of this technique was to describe a way to obtain accurate complete-arch digital impressions without stereophotogrammetry technology. The technique requires a single device: the intraoral scanner. However, the area must be scanned twice to restore and build the digital impression by combining 2 STL files.

TECHNIQUE

The technique consists of obtaining 2 different STL files. One provides an accurate position of the scannable impression copings (Scan Body; Straumann), with the surrounding soft tissues hidden. The second STL file provides an image of the soft tissues, and the digital impression is achieved by combining the 2 files.

1. Make an implant-level digital complete-arch impression of the edentulous patient, including the scannable impression copings (Scan Body; Straumann, with an intraoral scanner (TRUE DEFINITION, Hardware version 6.0; 3M ESPE) (Fig. 1).

2. Based on the STL file obtained in Step 1 and using a 3D-design software (Solid Edge; Siemens), design the auxiliary device, which fits in the patient´s mouth. This design will depend on the number and position of the scannable impression copings and must leave them visible for the intraoral scanner. The design broadly replicates a complete denture (Fig. 2)

3. Fabricate the auxiliary device in acrylonitrile butadiene styrene (ABS) with a 3D printer (3D Dimension Elite; Stratasys). ABS is a common nontoxic thermoplastic polymer. Among other features, it is opaque and shows in the scan.

4. Seat the auxiliary device in the patient's mouth, leaving the upper side of the scannable impression copings visible, and lute it into place with light-polymerizing resin (CONLIGHT, Kuss Dental)

5. Make a second complete-arch digital impression of the edentulous patient with the intraoral scanner. As the auxiliary device provides the scanner with shapes that facilitate the alignment of the multiple images, an accurate position is achieved of the scannable impression copings and consequently of the implants (Fig. 3).

6. Using reverse engineering software (Geomagic Studio; 3D Systems), remove the auxiliary device from the digital impression (Fig 4). Leaving as much surface area as possible of the scannable impression copings, erase the rest of the mesh. These impression copings will be the reference position for constructing the definitive digital complete-arch impression.

7. Using the reverse engineering software, virtually partition the digital impression achieved in the first step. Split the image obtained from the scanning without the auxiliary device into as many parts as scannable impression copings (Fig.5).

8. Using the reverse engineering software, align each part of the split digital impression (obtained in Step 6) with the accurately positioned scannable impression copings (obtained in Step 7). These accurately-positioned scannable impression copings are those obtained with the auxiliary device. This device reduces the error in distances between scannable impression copings (Fig.6).

DISCUSSION

This technique offers a solution for obtaining complete-arch digital impressions of edentulous patients, where scanning could be complicated.[17] The scanner requires an irregular shape with no repetitive adjacent surface structures to perform accurate digital impressions and in edentulous patients, this is what is missing.

The use of the auxiliary device fills this deficit. Its use has some drawbacks–it must be fabricated, properly fixed in the mouth, and requires 2 scans–all of which increase material costs and time. However, a single intraoral scanner is used and is applicable to both complete and partial-arch restorations.

SUMMARY

The technique presented improves the accuracy of a complete-arch impression for an edentulous patient. In areas with homogeneous geometry, a low-cost and easy-to-manufacture device with auxiliary geometry manufactured in ABS with a 3D printer was added.

By combining scans and using reverse engineering software, an accurate complete-arch impression of an edentulous patient is achieved.

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FIGURES

Figure 1. A, Edentulous case with 4 scannable impression copings. B, STL file after scanning. STL, Standard tessellation language.

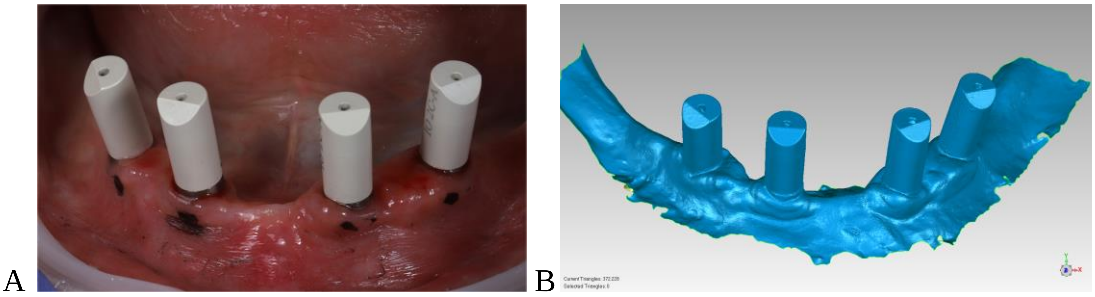

Figure 2. Auxiliary device design process

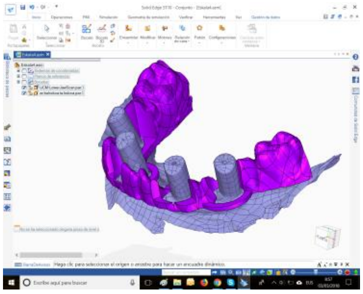

Figure 3. A, Auxiliary device fixed to edentulous jaw with scannable impression copings. B, STL file after scanning. STL, Standard tessellation language.

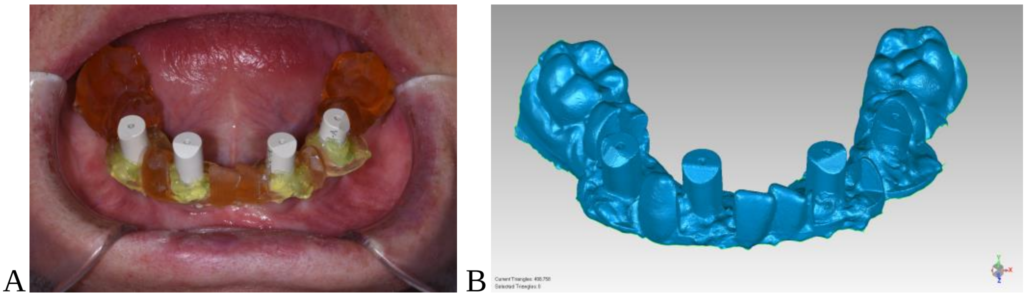

Figure 4. A, Selection of auxiliary device and soft tissues with reverse engineering software. B, Reference position of scannable impression copings after erasing auxiliary device and soft tissues.

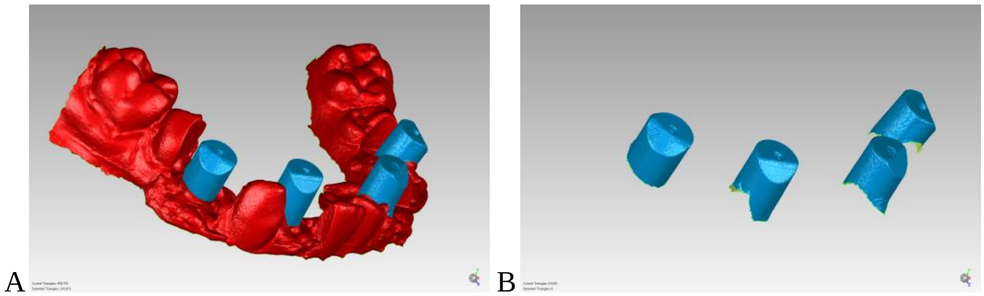

Figure 5. A, Virtual partition of digital impression of complete arch. B, C, D, E, Each splitted part of complete arch.

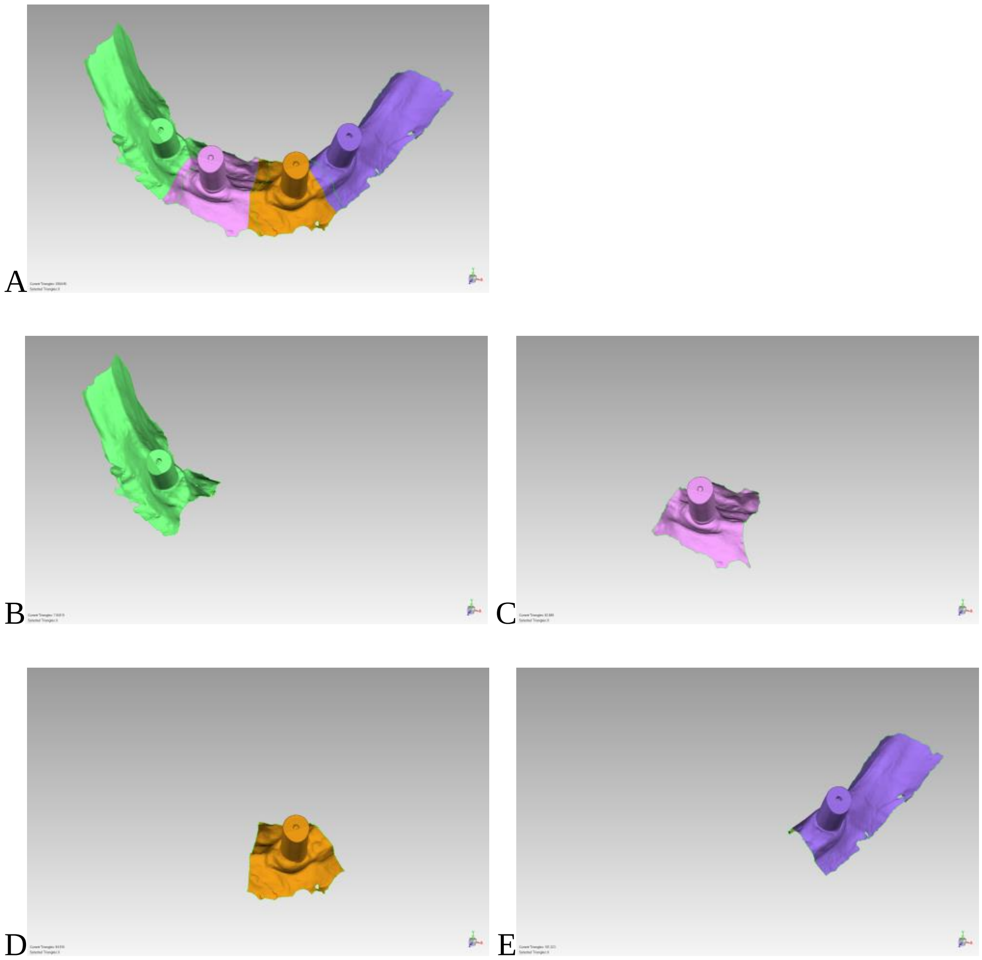

Figure 6. Construction of digital complete-arch impression.