Feasibility and Accuracy of Digitizing Edentulous Maxillectomy Defects: A Comparative Study

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Purpose: The aim of this study was to evaluate the feasibility and accuracy of using an intraoral scanner to digitize edentulous maxillectomy defects. Materials and Methods: A total of 20 maxillectomy models with two defect types were digitized using cone beam computed tomography. Conventional and digital impressions were made using silicone impression material and a laboratory optical scanner as well as a chairside intraoral scanner. The 3D datasets were analyzed using 3D evaluation software. Results: Two-way analysis of variance revealed no interaction between defect types and impression methods, and the accuracy of the impression methods was significantly different (P = .0374). Conclusion: Digitizing edentulous maxillectomy defect models using a chairside intraoral scanner appears to be feasible and accurate. Int J Prosthodont 2017;30:147–149. doi: 10.11607/ijp.5095

Making conventional impressions for obturators in maxillectomy patients is challenging and carries the risk of aspiration, foreign body impaction, and impression deformation associated with large undercuts. Digital technology has been used in maxillofacial rehabilitation to plan surgical reconstruction and create surgical templates. Although computed tomography (CT) and magnetic resonance imaging data have been used to fabricate models of defects involving the jaw and the vocal tract, the resolution of these images is inadequate for fabrication of dental prostheses with retainers.

Since the introduction of computer-aided design/computer-assisted manufacturing (CAD/CAM) applications in dentistry, technology has evolved to allow the creation of intraoral digital impressions from which high-resolution data of prepared teeth can be obtained directly. Generally, the use of intraoral scanners has been limited to the digitization of teeth and implants and the fabrication of fixed dental prostheses. However, a recent study revealed that currently available devices can digitally capture edentulous jaws in vitro. The purpose of the present in vitro study was to evaluate the feasibility and accuracy of digitizing edentulous maxillectomy defects using an intraoral scanner and compare this method to the conventional technique.

Materials and Methods

A flowchart detailing the data acquisition process is given in Fig 1.

Scanning

Edentulous maxillectomy defect models were grouped into two maxillectomy defect types (quarter or half of the maxilla; Fig 2). As a reference, 10 polyurethane models (Resinast Ex Non Xylene Ivory, Wave) for each group were digitized using high-resolution (voxel size 100 µm) cone beam computed tomography (CBCT) (ProMax 3D Mid, Planmeca Oy). Conventional impressions were made by making silicone rubber impressions (GC) of the polyurethane models and pouring them with type III dental stone (Pico-crema soft, Picodenl). Stone models were then scanned with an optical scanner (IScan D101, Imetric 3D). For digital impressions, the polyurethane models were dusted with titanium oxide powder and scanned in zigzag manner from the nondefect side to the defect side using a chairside intraoral scanner (3M True Definition, 3M ESPE). The scanned data were checked for surface-scanning quality on the scanner monitor, and scanning time was recorded.

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**3D Modeling and Evaluation**

The CBCT scan data were first saved as a stack of digital imaging and communication in medicine (DICOM) files, rendered to 3D surface models (Planmeca Romexis 3D, Planmeca Oy), and then saved as standard triangulated language (STL) files. Intraoral scanned data were sent to the scanner provider (3M ESPE) for processing, and then saved as an STL file. Optical scan data obtained from the laboratory scanner were directly saved as STL files. The 3D datasets were geometrically superimposed using the best-fit algorithm of 3D evaluation software (spGauge, Armonicos) (Fig 3), and the software calculated the mean absolute 3D deviations. Two-way analysis of variance was performed to compare differences in absolute 3D deviations between defect types and impression methods ($P < .05$).
Results

The entire surface of the maxillectomy defect models was successfully scanned regardless of structural complexity, modeled as 3D data, and geometrically evaluated. All scans were performed in 7 minutes or less. The overall mean 3D deviation ± standard deviation of the conventional impressions was 247.7 ± 128.8 µm and 197.2 ± 81.7 µm in the quarter- and half-defect cases, respectively. For digital impressions, the overall mean 3D deviation was 168.3 ± 19.3 µm in the quarter-defect cases and 170.2 ± 24.0 µm in the half-defect cases. There was no interaction between defect types and impression methods. Accuracy was significantly different between the two impression methods ($P = .0374$), but not between the two defect types ($P = .3306$).

Discussion

Computerized optical impression making is a promising technology for simplifying current impression methods. This in vitro study showed the feasibility and accuracy of digitizing edentulous maxillectomy defects using an intraoral scanner and compared it to the conventional technique. Although several in vitro studies have compared the accuracy of digital and conventional impressions, to the authors' knowledge there have been no in vitro or in vivo studies on digitizing edentulous maxillectomy defects using an intraoral scanner.

CBCT scanning was chosen as a reference because of its accuracy and because it does not interfere with the structure of complex maxillectomy defects. During fabrication of definitive casts for indirect digital impressions using conventional techniques, laboratory errors such as shrinkage, irregular thickness, or detachment of the impression material and distortion of the impression are inevitable—especially in the case of maxillectomy defects, which are large and have deep undercut areas. Dimensional changes caused by expansion of the dental stone are also problematic. Because of these limitations, certain shallow and deep defects cannot be successfully scanned.

The 3M True Definition intraoral scanner, which requires applying a light dusting of spray powder to the polyurethane models to avoid reflections and create a measurable surface, was used in this study. Future studies should incorporate the use of other intraoral scanners as well to evaluate the feasibility of using scanners without the need of powder. This study did not simulate oral environmental factors such as jaw opening, saliva, and soft tissue, which would be encountered in clinical situations.

Conclusions

Digitization of edentulous maxillectomy defect models via chairside intraoral scanning appears to be feasible and accurate in an in vitro setting. The present investigation suggests that future studies are necessary to clinically verify the feasibility of digitizing edentulous maxillectomy defects.

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