Journal of
Babol University of Medical Sciences
JBUMS
e-ISSN: 2251-7170 p-ISSN: 1561-4107

Evaluating the Accuracy of Two Complete Denture Impression Techniques Compared to Traditional Technique Using a Laboratory 3D Scanner

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Article Type

Research Paper

Received:
Apr 3rd 2024
Revised:
Jun 11st 2024
Accepted:
Oct 12nd 2024

ABSTRACT

Background and Objective: One of the important steps in making a complete denture is impression making, which is performed using different materials and techniques with differences in the accuracy of recording details, cost, time, etc. Using a technique that is simple yet accurate is beneficial for dentists and patients. The present study was conducted to evaluate the accuracy of two complete denture impression techniques compared to traditional technique using a laboratory 3D scanner.

Methods: This quasi-experimental study was conducted using impressions taken from the maxilla of 12 randomly selected patients. For each patient, impressions were taken using three techniques: traditional (zinc oxide eugenol) as the reference and comparative techniques (alginate and compression silicone). To compare the techniques, a laboratory 3D scanner and an analysis software were used which expressed the difference between the two surfaces in millimeters (mm). The mean results obtained from comparing each technique with the reference technique were expressed for the entire jaw surface and also for different areas.

Findings: In examining the surface of the impression, the difference with the traditional technique was 0.56±0.14 mm for alginate and 0.491±0.136 mm for silicone. In the border area, obtained values were 1.303±0.423 mm for alginate and 1.119±0.318 mm for silicone. The side alginate and posterior palatal seal areas in both techniques showed a median difference of about 0.5 mm, and the side silicone, alveolar ridge and central sulcus areas in both techniques showed a smaller difference (about 0.2 mm) ($p \leq 0.001$).

Conclusion: The results of the study showed that alginate and compression silicone technique are more accurate in impression making compared to the traditional technique.

Keywords: *Oral Impression Technique, Complete Denture, Software Analysis, 3D Scanning*.

Cite this article: Mohammdpour Tahmtan A, Ghanavati Z, Shirgahi Talari F. Evaluating the Accuracy of Two Complete Denture Impression Techniques Compared to Traditional Technique Using a Laboratory 3D Scanner. *Journal of Babol University of Medical Sciences*. 2025; 27: e63.

[DOI: 10.22088/jbums.27.1.63]

Introduction

Edentulism is a common problem that affects oral health and the general health of the individual (1). Complete edentulism is usually treated with a complete removable prosthesis, the most important step of which is the impression (2). There are various techniques for impression taking, which, in addition to the accuracy of recording details, also differ in cost, time, skill required, etc. (3). One of the simplest techniques is the one-step alginate impression. This technique is popular among dentists and is widely used because it is cost- and time-efficient (4). Another technique is the traditional technique (which includes two stages of initial and final impression) which is performed using a material such as ZOE (zinc oxide eugenol) (5). In this technique, after the initial impression is prepared, a special tray is prepared, the borders of which are shaped in the patient's mouth by a compound during border molding, and finally the final impression is prepared (6).

Using a technique that is simple yet accurate is a great help to dentists and patients. For this purpose, different techniques can be compared in terms of accuracy. Chebib et al. conducted a study on 12 patients to evaluate the accuracy of four impression techniques (alginate, silicone, silicone with ZOE, and intraoral scanner) compared to the traditional technique (ZOE) using a laboratory scanner. A significant difference was observed between different techniques. It was demonstrated that the alginate impression has a greater difference, but the other techniques showed acceptable results (7). Regis et al. compared two simplified techniques (one-step with alginate) and traditional techniques (two-step with ZOE) for denture fabrication. The results showed that the simplified technique, although less expensive and time-consuming, did not differ in quality of life, denture quality, and general patient satisfaction (8).

Since the number and quality of research in this field is not sufficient for dentists to be confident in choosing the desired technique, the present study was conducted to compare the accuracy of two complete denture impression techniques compared to traditional technique using a laboratory 3D scanner.

Methods

After approval by the Ethics Committee of Babol University of Medical Sciences with the code IR.MUBABOL.HRI.REC.1401.211, this quasi-experimental study was conducted on impressions taken from 12 patients. The inclusion criteria included complete edentulism in the maxilla and informed consent to participate in the study, and the exclusion criteria included excessive alveolar ridge resorption. These patients were randomly selected from among the patients of the prosthetics department of Babol Dental School, and the number of patients was based on a similar study by Chebib et al. (7).

Three different impression techniques were performed on the maxilla of each patient by one of the researchers (12 impressions were taken for each technique, for a total of 36 impressions). The first technique was a one-step impression using alginate (Cromogel - Marlik Medical Industries) in a prefabricated tray, similar to the CD4 technique (9). The second technique was a two-step impression in a dedicated tray, without border molding, using compression silicone (Speedex - Asia Chemiteb) with low concentration (wash), and the third technique (traditional technique) was a two-step impression using ZOE (Outline - Cavex) in a dedicated tray with a molded border, which was considered the reference impression (5, 10). To compare the casts obtained from the impression, a laboratory 3D scanner (Ceramill Map 200+ - AmannGirrbach) was used and then the prepared files were automatically matched with a 3D analysis software (Rapidform v3.1 - Inus Technology) to determine the amount and location of possible differences

[DOI: 10.22088/jbums.27.1.63]

in the casts by examining the distance between the points of similarity between the two files. The software calculates the root mean square (RMS) of the differences between the points of similarity, and shows the difference between the two surfaces in millimeters (Figure 1).

In this study, the mean RMS obtained from the difference between each proposed technique and the reference technique was expressed for the entire jaw and also for different parts including the mold border, buccal wall of the alveolar ridge (side), ridge, raphe (central palatal sulcus) and the PPS (posterior palatal seal) area. To analyze the results, one sample t-test and ANOVA test were used, and $p<0.05$ was considered significant.

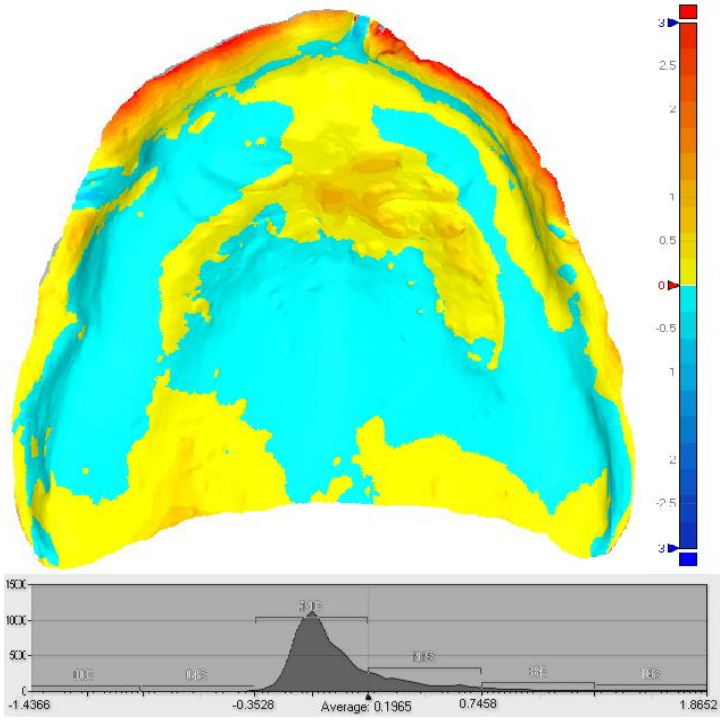

Figure 1. An example of surface comparison in the software
(Comparison of the overall surface of an alginate cast with a ZOE cast in a patient)

Results

In evaluating the difference in the total surface area of the impressions compared to the reference impression, the RMS value for the silicone technique was 0.491±0.136 mm and it was 0.560±0.140 mm for the alginate technique. For the border area of the impression, in the silicone technique, the value was 1.119±0.318 mm and in the alginate technique, the value was 1.303±0.423 mm. Examination of the software analysis images in both techniques shows that there are more points with positive differences and their numerical value is larger, which indicates that this area is shorter in the molds taken compared to the ZOE mold.

In comparing the side area, the value was 0.271±0.090 mm for silicone and the value was 0.468±0.214 mm for alginate. In the side alginate area, most of the difference was negative and as a result, the alginate mold in this area was more protruding.

[DOI: 10.22088/jbums.27.1.63]

In the ridge area, the value was 0.185±0.073 mm in the silicone technique and the value was 0.197±0.068 mm in the alginate. In the raphe area, the value was 0.156±0.092 mm for silicone and 0.130±0.067 mm for alginate. Moreover, the comparison of the PPS area showed a value of 0.513±0.0415 mm for silicone and 0.495±0.0348 mm for alginate. In this area, both impression techniques had more positive points, indicating that the impression was shorter and there was a distance between it and the tissue. A p-value of ≤0.001 was determined in all the values.

The results of comparing the different areas of each impression with each other, which were evaluated by ANOVA test, are given in Table 1 for the alginate technique and in Table 2 for the silicone technique. As the results show, the border area of both techniques is significantly different from the reference technique compared to other areas (p<0.001).

Table 1. Differences between different areas of the alginate technique

Area	Mean differences (mm)	p-value
Border		
Side	0.834	<0.001
Ridge	1.105	<0.001
Raphe	1.172	<0.001
PPS	0.807	<0.001
Side		
Ridge	0.271	0.107
Raphe	0.338	0.024
PPS	-0.026	0.999
Ridge		
Raphe	0.067	0.972
PPS	-0.297	0.062
Raphe		
PPS	-0.364	0.012

Table 2. Differences between different areas of the silicon technique

Area	Mean differences (mm)	p-value
Border		
Side	0.848	<0.001
Ridge	0.933	<0.001
Raphe	0.962	<0.001
PPS	0.605	<0.001
Side		
Ridge	0.085	0.911
Raphe	0.114	0.778
PPS	-0.242	0.119
Ridge		
Raphe	0.029	0.998
PPS	-0.327	0.014
Raphe		
PPS	-0.356	0.006

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Discussion

The results of this study demonstrated that there is a difference between the alginate and silicone techniques compared with the traditional technique, and there a difference in the accuracy of recording different areas in the proposed impression techniques.

The results of this study are consistent with the studies of Chebib et al. and Kalberer et al. (7, 11), especially in the border area of the alginate impression, and in these studies, the value of this area was greater than other areas. The reason why there was the greatest difference in the border area of the proposed techniques could be the lack of border molding. In the alginate technique, the impression is made with a prefabricated tray and the necessary functions for recording the border area are given to the tissues during the impression. Due to the incomplete correspondence of the prefabricated tray with the depth of the sulcus and the short setting time of the alginate, there is sensitivity in recording the border area (6). In the silicone technique, although a dedicated tray is used, there is still sensitivity in the border area due to the lack of border molding.

Also in those studies, the side and PPS areas were in the next level. The PPS areas of the two proposed techniques and the alginate side were in the next level in terms of the amount of difference. In the PPS area, the reason for this difference may be the lack of border molding. Accurate registration of the area in the proposed techniques depends on the accuracy of the tray. Moreover, due to the anatomy of this area, the impression must be made with appropriate pressure to place the soft tissue in the ideal location (10). The silicone used (wash) and alginate have a low consistency and may not be able to provide the ideal pressure for tissue displacement.

Some studies that used patient-centered evaluations have shown mixed results. In a systematic review by Sanjeevan et al., patient satisfaction and Oral Health Related Quality of Life (OHRQoL) were found to be equivalent in simplified techniques compared to the traditional technique (3). In a study by Regis et al. (8), no significant difference in OHRQoL and overall satisfaction with dentures was observed. Carlsson et al. also reviewed the simplified technique and concluded that one-stage alginate impression taking in a prefabricated tray had clinical outcomes that were equivalent to two-stage impression taking techniques that are more complex, costly, and time-consuming (12).

Of course, the results of these studies are not completely comparable to the objective outcomes of this study (difference in measurements in millimeters) due to the difference in the evaluated outcome (patient satisfaction and quality of life); however, the existence of this evidence, based on the patient's perception of these techniques being similar, can be an indication of an acceptable range for the difference between impression techniques.

Due to the lack of a standard limit for acceptable difference in impression taking, finding the differences in values compared to the traditional technique alone cannot give a definitive opinion and reject or accept a technique. Nevertheless, the differences in the areas of an impression technique are valuable in finding the weaknesses of each technique and a criterion for modifying that technique. For example, the higher values of the border area in both techniques indicate that this area is more sensitive and its recording process can be re-examined.

Acknowledgment

We would like to express our gratitude to the Vice Chancellor for Research and Technology of Babol University of Medical Sciences for their financial support of the research, as well as to a group of students from the Prosthetics Department of Babol Dental School who assisted in conducting this study.

[DOI: 10.22088/jbums.27.1.63]

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[DOI: 10.22088/jbums.27.1.63]