Comparative Analysis of Dimensional Accuracy of Two Types of Silicone Impression Materials: Optosil and Elite-HD

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Abstract

Statement of the Problem: Understanding about impression materials, their properties, uses and manipulation can guide operators towards having more successful restorations. Purpose: The aim of this in vitro study was to compare the accuracy of a condensation silicone impression material, Optosil, and an addition poly siloxane impression material, Elite-HD. **Materials and Method:** A laboratory model with two metallic dies was used to make impression. A horizontal notch on one of the two dies simulated an undercut. Ten impressions were made by each impression material by the putty-wash technique. After pouring impressions with velmix die stone, a total of 20 stone casts were made from both materials. Measurements of casts were compared with the master model. Statistical analyses were performed using t-test.
Result: This results of this study showed that the height of die without undercut decreased in both groups. Also the height above the undercut decreased in both groups, which was more obvious in Elite-HD group than Optosil group. The distance between dies increased in both groups, with higher figures for Elite-HD. So, Optosil is a more accurate material for registering inter-abutment distance than Elite-HD. The diameter of die under the undercut decreased in Optosil group and was similar to the master model in Elite-HD. Statistical analysis showed significant differences between these two groups in the distance between abutments (p=0.001), the diameter of die under the undercut (p=0.014) and the height of die above undercut(p=0.057). **Conclusion:** Optosil is more accurate in registering inter-abutment distance than Elite-HD, so Optosil is preferred for fixed partial denture impressions. Since Elite-HD showed more accuracy in C measurements than Optosil, it is preferred for single crown impressions.

Keyword: Dimensional Measurement Accuracy, Elastomeric Impression Materials, Polyvinyl Siloxane, Dimensional changes.

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Introduction

Impression materials record the details of oral tissues and replicate oral structure. Impression is a negative form of tissue. Positive forms are achieved by pouring the impression with dental stone or other suitable materials. The positive form is called mold or cast (1). an accurate impression material is needed have a precise cast which is the most important factor in accuracy and prognosis of restorations. Dimensional accuracy during making impression is a crucial factor for successful prosthodontic treatment.[2] Impression techniques and the quality of impression material have significant roles in the success and prognosis of prosthodontic treatments (3,4). However, some studies have shown that there is no difference between one and two step putty-wash impression techniques[5,6]; however, other studies showed that two step impression technique is preferred for silicone materials.[7,8] Elastomeric impression materials have been the gold standard material for dental impressions in fixed prosthodontics for almost 50 years (9). The widespread use of silicone putty-wash technique relates to their accuracy, ease of handling and ability to use them with stock trays (10).

The disadvantage of polymerization shrinkage of condensation silicone has been overcome by addition of silicones to inhibit release of by products (11). The broad use of addition silicone impression materials in both fixed and removable prosthodontics relates to their dimensional accuracy.[3,12] Other advantages relate to their excellent elastic recovery, ease of handling, ability to produce several casts from one impression and good detail reproducibility. One significant limitation of Polyvinylsiloxane (PVS) impression material is its hydrophobicity that is why manufacturers have produced hydrophilic PVS resulting in increased wettability of the polymerized impression with gypsum slurries (12).

The properties of some recently marketed rubber impression materials were comparable with some earlier products. Since there were significant differences among the properties of products in one same category, selection of a product for a particular application should be based on the actual properties rather than on the type and class of the rubber impression material (13).

Generally, 3 methods are used to evaluate the accuracy of an impassion material:

1. Using *in-vitro* models for evaluation of dimensional accuracy of impression materials
2. Evaluating marginal fitness of crowns on models
3. Comparing dimensions of cast with the master model (14).

Kalantari and safari evaluated dimensional accuracies of two types of condensation silicone and suggested that Speedex, as an impression material, was more accurate than Irasil in most cases (14).

Sazegara and Yavari compared the accuracies of two different condensation silicone impression materials and reported that Alphasil was more accurate than Optosil (15).

Several studies suggested using special trays for fixed partial denture impressions to provide uniform thickness of the impression materials specially when using poly ether and poly vinyl siloxane (16).

Al-Zarea and Sughaireen who investigated the accuracy of four commercial types of addition silicone impression materials, reported maintanence of high accuracy over time for them (3).

The purpose of this in vitro study was to compare the accuracy of Optosil (a condensation silicone impression material) and Elite-HD (an addition poly siloxane impression material) to investigate possibility of replacing Optosil with a cheaper product. The null hypothesis was that there is no difference between dimensional accuracies of the two types of impression materials.

Materials and Method

A stainless steel master model was used to make impression. The model contained 2 parts:

1) A metallic base and two metal dies with 3° tapered walls and rounded cross sections. One of the dies had a horizontal groove to simulate an undercut. The base had 4 guide bars to determine path of special tray insertion.

2) The upper part was a metallic special tray with holes simulating prefabricated trays to let impression material exit leading to decreased internal pressure. There were 4 holes for insertion of guide bars.

In addition, the model included:

a. A 1.5 mm aluminum spacer to create space for wash material.

b. An acrylic box to sit on the special tray and act as boxing to facilitate gypsum pouring and bringing out stone model. (fig.1)

Two impression materials were tested in a recommended room temperature (25°C) and humidity of 50% (± 10%):

1. Optosil Xantopren (Heraeus Kulzer Germany) a condensation silicone impression material

2. Elite-HD (Zhermack Italy) an addition silicone impression material.

Ten impressions were made by each impression material by the putty-wash (reline) technique. Before making putty impression, an aluminum spacer of 1.5 mm thickness was placed on the base to make an appropriate space for application of wash material. Then, putty impression material was mixed and put in the upper part, the metallic special tray. The tray was then placed on the metallic base by pressure to be completely seated and let the material set as recommended by the manufacturer company. After putty was set, the tray was taken off and the wash spacer removed, followed by mixing wash material and inserting it in putty around dies .The tray was again seated on the base until the wash material set. The pressure for seating the tray on the base was the same in the two stages of impression process. Optosil and Elite- HD impressions were poured after 45 minutes and 2 hours respectively, this time lapse was suggested by the manufacturer with consideration of the Rebound Phenomenon. Type IV die stone (velmix die stone, Siladent, Germany) was mixed with a ratio of 50 gm stone to 10 ml water. After pouring impressions with dental stone a total of 20 stone casts were made from both materials.

The accuracy of the impression material was measured by analyzing the five dimensions as below:

A: Height of die without undercut B: Diameter of die without undercut C: Distance between dies D: Diameter of die beneath undercut, and E: height of die above undercut on stone cast poured from impressions of a stainless-steel master model and compared with master model by profile meter-sip-universal, Switzerland (accuracy:0.0001 mm). For more accuracy, each area was measured 3 times by a specialist who didn't know the type of impression material (Fig.2). A,B& C revealed impression accuracy of bridge and D & E showed dimensional changes of the impression material while being pulled out from undercuts. The minimum, maximum, means, standard deviations and mean percentage differences were calculated for each impression material. Data was collected and analyzed using t-test since the distribution of data was normal. The significance level was set at p = 0.05 for all statistical analyses.

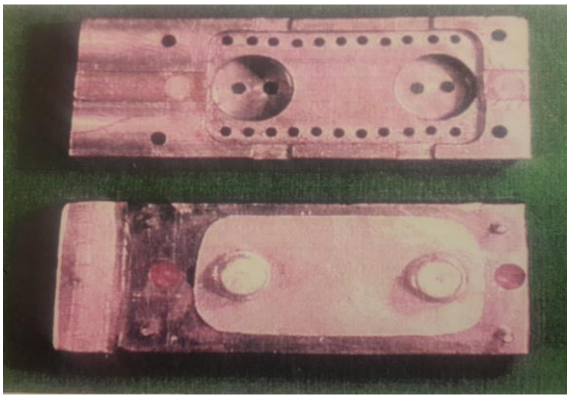


Figure. 1. Master model

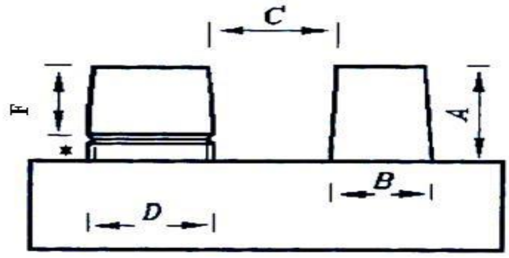


Figure. 2. 5 dimensions (A/B/C/D/E) were measured on master model and stone casts

Result

The results of this study include. Minimum, maximum, means and SD measurements of the 5 dimensions (A, B, C, D, E) on stone models for the two impression materials, Optosil (group 1) and Elite-HD (group 2): are shown in table-1. The Heights of die without undercut (A) minimum, maximum, and mean measurements for Optosil were 11.25 mm, 12.29mm and 11.97 respectively. The mean height in Optosil group was 0.2250 mm less than the master model with standard deviation of 0.3349.The minimum, maximum and mean of Elite-HD group was 11.11, 12.06 and 11.71 mm respectively. The height of die without undercut in master model was 0.4759 mm more than the average value of Elite-HD group. The standard deviation was 0.2791.

In group B (the die without undercut), the minimum, maximum and mean diameter in Optosil group were 10.32, 10.75 and 10.4673 mm respectively. The standard deviation was 0.1555.For the Elite-HD group, the minimum and maximum figures were 10.29 and 10.43mm respectively .The mean was 10.4012 mm so it showed a 0.0333 mm decrease in comparison with the master model. The standard deviation was 0.04156.The results for the distance between dies (C) for Optosil group revealed a minimum of 33.85 mm and a maximum of 33.95 mm. The mean dimension between dies was 33.9030 mm that was 7.49×10^{-3}mm more than the master model. The mean distance in Elite-HD group was 0.0591 mm more than the master model.h

The minimum and maximum diameter of dies beneath undercut (D) was 10.14 and 10.36 for Optosil versus 10.27 and 10.37 for Elite-HD. The mean diameter in Optosil was 0.06302 mm less than the master model while in the Elite-HD group; it was 1.23×10^{-2}mm more than the master model.

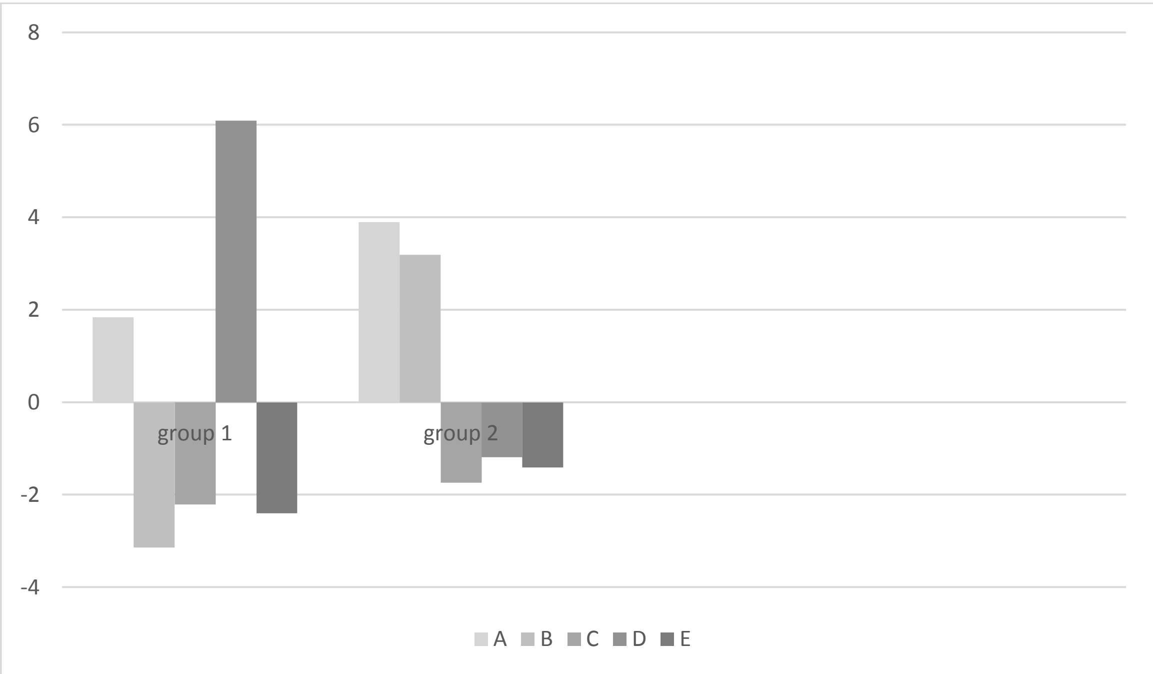
The minimum and maximum height of die above undercut (E) was 9.62 and 10.09 for Optosil versus 9.87 and 10.14 for Elite-HD group. The mean height in Optosil and Elite-HD groups were 0.0236 mm and 0.1391 mm more than the master model.

Statistical analysis with t-test showed significant differences between these two groups in C, the distance between abutments (p=0.001), and D, diameter of die under the undercut (p=0.014) and E, the height of die above the undercut (p=0.057). (Table-1)

The percentage differences between the measurements of the stone casts and the master stainless steel model are shown in graph1.

Table 1. Minimum, maximum, means, SD of measurements and Statistic analysis with t-test On the stone models for the 2 impression materials (N=10)

	Group	Minimum	maximum	mean	Std.deviation	t-test	df	Sig(2-tailed)
A	Optosil	11.2473	12.2870	11.9701	0.3349	1.821	18	0.085
	Elite-HD	11.110	12.0603	11.7191	0.2791			
B	Optosil	10.319	10.7490	10.4673	0.1555	1.298	18	0.211
	Elite-HD	10.2870	10.4355	10.4012	4.156E-02			
C	Optosil	33.8525	33.9575	33.9030	3.381E-02	- 3.771	18	0.001
	Elite-HD	33.9305	34.000	33.9546	2.695E-02			
D	Optosil	10.1357	10.3690	10.2725	8.261E-02	- 2.708	18	0.014
	Elite-HD	10.2675	10.3702	10.3478	3.025E-02			
E	Optosil	9.6240	10.0855	9.8569	0.1529	- 2.033	18	0.057
	Elite-HD	9.8795	10.1415	9.9724	9.422E-02			



Graph 1. Percentage of deviation from master model in 5 dimensions (A/B/C/D/E)

Discussion

Silicone impression materials have become popular among clinicians. In addition to the type of the silicon material, different commercial silicones in terms of manufacturer's trade name have shown to have different accuracies. The current study investigated the accuracy of two types of silicones: Optosil (condensation silicone) and Elite-HD (addition silicone)

The null hypothesis was that there is no difference between dimensional accuracies of two types of impression materials. Our study showed that there were significant differences between the accuracies of these two materials in measuring the distance between the two abutments(C), the diameter of die under the undercut (D) and the height of die above undercut (E). So the null hypothesis was rejected.

The height of die without undercut (A) decreased in both groups. The mean diameter of dies without undercut (B) increased in Optosil group and decreased in Elite-HD but they were not statistically significant. Both groups showed increased distance between dies(C). Similar to the study of Sazegara et al, the increase was more significant in Elite-HD than Optosil. [15] The decrease in A and increase in C may be related to polymerization shrinkage of the impression materials. Contractions of the impression material toward the tray walls, was responsible for making a wider and shorter die stone. [7]

In Optosil group, the dimension of die under the undercut (D) decreased, but the measurements of D in Elite-HD group were similar to the master model. Increase in E in Elite-HD was more than Optosil. Both the existence of undercut and elongation of impression material during taking out the tray may cause enhancement in dimensions of E. Statistical analysis showed significant differences between these two groups in C, distance between abutments ($p=0.001$), D, diameter of die under the undercut ($p=0.014$) and E, the height of die above the undercut ($p=0.057$). (Table1).

In Stockhouse study, on the accuracy of condensing silicone in different methods, both *the height of die without undercut (A) and* the diameter of die under the undercut(D) was decreased similar to Optosil impression material. (17) Sazegara and Yavari's study on Alphasil and Optosil, two types of condensation silicone, showed similar dimensional changes to Optosil (15).

In a study by A-Zarea and Sughaireen (3) on the accuracy of four commercial types of addition silicone impression materials, maintanence of high accuracy over time was proved for this group of impression materials. It is mentioned that these materials can be poured over 4 weeks without any significant dimensional changes.

In the study of Kalantari and Safari, two types of condensation silicone impression materials by the putty wash technique were evaluated. They reported high accuracy for Speedex in contrast with Irasil in all dimensions except the height of die above undercut. [14] It has been mentioned recently that condensation-silicone (Optosil), showed more accuracy in B and C measurements and less accuracy in E measurements.

Although computer guided systems in dentistry such as CAD-CAM, provide broad possibility and facilities for intraoral tissue registration, using impression materials still remains a reliable method.

We also recommend a similar in vivo research for future studies because Oral conditions such as bleeding, saliva and temperature have important effects on making an accurate impression.

Conclusion

The statistical analysis in this study showed that there were significant differences between these two materials in the distance between two abutments, the diameter of die under the undercut and the height of die above undercuts. The differences for the master model in C measurements were more distinct in Elite-HD group. Measurements of D in Elite-HD group were closer to the master model. It proved that Optosil is more accurate than Elite-HD in measuring inter-abutment distance, making Optosil more preferable for fixed partial denture impressions. Since Elite-HD showed more accuracy in C measurements than Optosil, it is preferred for single crown impressions. Moreover, there was no significant difference between the impression materials in E index measurements.

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