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Dimensional Accuracy of Two-Step Impressions Relined with Extra-Light Addition Silicone Material

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A B S T R A C T

Objectives: Some small defects may remain in the impression after making a two-step putty-light body impression. The aim of this study was to evaluate and compare the dimensional accuracy of 2-step and relined 2-step (3-step) putty-light body impressions.

Materials and Methods: In this in vitro study, 30 impressions were made with putty, light body, and extra-light body addition silicone materials using the 2-step and 3-step impression techniques (N=15). An epoxy resin master model was made duplicating a maxillary typodont with left first premolar and first molar teeth prepared with a shoulder finish line and truncated pyramidal-shaped indices in the mid-palate and third molar sites. In addition to creating a reference digital model by scanning the master model, 30 master casts were scanned to produce digital models. The anteroposterior (AP) and cross-sectional (CS) dimensional accuracy of the models were compared with the master model using linear measurements. Moreover, tooth size measurements were made and compared using the root mean square (RMS). Two-sample t-test was applied to analyze the data (α=0.05).

Results: The mean AP and RMS differences between the two study groups were not significant ($P>0.05$). However, the CS difference between the two groups was significant ($P<0.001$), and the 3-step impression technique showed smaller discrepancies in comparison to the master model.

Conclusion: There was no significant difference in accuracy of the two techniques for single-unit and multiple-unit preparations. The 3-step impression technique had a higher CS dimensional accuracy.

Keywords: Dental Impression Materials; Dental Impression Technique; Tooth Preparation, Prosthodontic; Silicones

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INTRODUCTION

An accurate final impression could result in a master cast with minimal vertical and horizontal discrepancies in the prepared teeth [1]. However, several parameters may affect making an accurate impression such as the adopted

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impression material, and the impression technique [2]. Addition silicone impression material has the highest accuracy for making dental impressions [3]. This material is available in different viscosities for use with either the monophase or the dual-phase impression technique [4]. The two-step dual phase (putty-light body) technique with 1-2 mm space for the light body material is a common method for making impressions from the prepared teeth with rigid stock trays [2,3]. In this technique, reproduction of the preparation details, especially at the margins, would be feasible with a uniformly thin layer of light body material [1-5]. However, when making impressions from multiple preparations with subgingival margins, all the details may not be correctly captured, especially when using a hydrophobic impression material. Since even minute errors could negatively affect the accuracy of the final restoration, the need for remaking the impression from the first step would be inevitable. However, remaking of impressions entails consuming more impression material, reusing the retraction cord, and wasting time, and may result in frustration of patient and dentist [6]. Therefore, it would be beneficial to avoid such complications with meticulous relining of 2-step impressions [7].

Using extra-light body addition silicone impression material does not require additional space in the impression according to the manufacturer. This is probably because of the higher flowability and less filler content of the extra-light body material in comparison to the light body material. These characteristics could make the extra-light body material a potentially suitable option for repairing the voids and small flaws of the second-step impression. Therefore, using this material for relining of an impression could be advantageous in terms of saving time and impression material. Also, it may eliminate the need for repeating the gingival retraction procedure if used immediately after the second step. However, its potential shortcomings include difficulty in seating the tray and distortion caused by the seating pressure [8]. Nonetheless, such shortcomings could be prevented by removing the set material from the undercut areas. The accuracy of the 3-step impression technique using the extra-light body material has not been previously studied. Therefore, this study aimed to compare the accuracy of the 2-step (with putty-light body materials) and the 3-step (with putty-light body and extra-light body materials) impressions. The null hypothesis of the study was that there would be no significant difference in the accuracy of the 2-step and the 3-step impression techniques using addition silicone impression material with three different viscosities.

MATERIALS AND METHODS

In this in vitro study (ethical approval code: IR.BPUMS.REC.1398.001), a dental model (No. 500B-1; Kilgore Intl., Coldwater, MI, USA) was used for preparation of maxillary left first premolar and first molar teeth as abutments for a multi-unit prosthesis with a shoulder finish line [9]. Three truncated pyramidal-shaped indices were made and fixed on the typodont with baseplate wax and type 4 dental stone (Tewerock, Kettenbach GmbH, Germany) at the site of third molars and at the mid-palate opposite to the first premolar for accurate aligning and superimposition of images of the resultant casts (Figure 1A) [10].

Furthermore, three external putty (Speedex, Coltene, Switzerland) indices were located on the anterior and lateral sides of the model for accurate tray positioning (Medisprex CE 891702 XL; Pakistan) and ensuring uniform thickness of the impression material (Figure 1A).

The model was then duplicated with epoxy resin (EP 85-215; Eager Polymers, Chicago, IL, USA) at 23ºC and 30% humidity (Figure 1B) using addition silicone impression material (Panasil, Kettenbach, Germany) and a metal stock tray.

After adapting a 1-mm thick thermoplastic sheet (Easy-vac; 3A MEDES, Ilsan-ro, Ilsandong-guGoyang, Gyeonggi-do, Korea) on the master model as a spacer [1], a metal stock tray filled with a fast-set addition silicone putty material (Panasil, Kettenbach, Germany) was seated on the model. After impression removal, the spacer was removed, and the impression was filled with the fast-set light-body addition silicone material (Panasil, Kettenbach, Germany) (Figure 2A) [3].

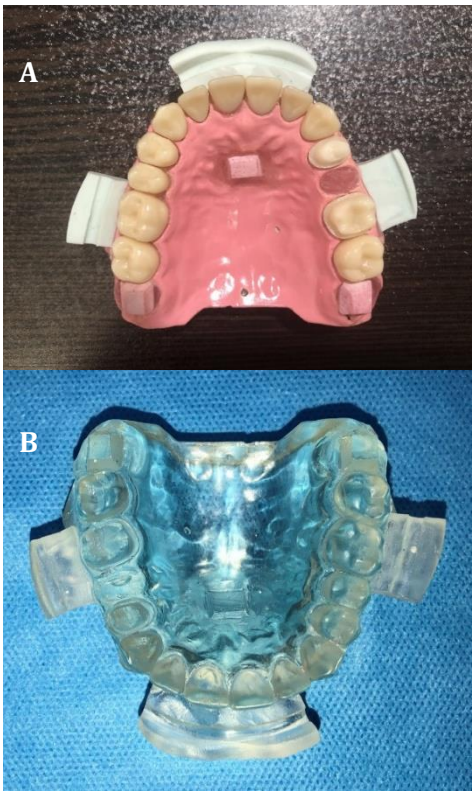

Fig. 1: (A) Original model with three truncated pyramidal-shaped indices using baseplate wax and type 4 dental stone at the site of third molars and at the mid-palate opposite to the first premolars with three external putty indices located at the anterior and lateral sides. (B) Duplicated epoxy resin model used for making impressions

This procedure was repeated for 30 impressions, and then they were randomly divided into 2 groups. According to a power analysis, 15 samples were assigned to each group to assess the strength of the study hypothesis with a statistical power of 90% and an error probability of 5%. Half of the impressions (N=15) were trimmed at the interproximal areas (except near the prepared teeth) for easy and accurate seating of the impression in the third step [7]. Next, extra-light body material (Panasil, Kettenbach, Germany) was injected into the impression in this group without producing any extra space (Figure 2B). All impressions were made by one expert operator, and impressions with any pressure spot, tear, incomplete seating, or uneven thickness of impression material were repeated. For impression removal, equal force was applied to both sides at the same sites for all impressions [12]. The setting time was considered slightly longer than the recommended time by the manufacturer (4 minutes vs. 2.5 minutes intraorally) due to the absence of intraoral moisture and temperature conditions [3].

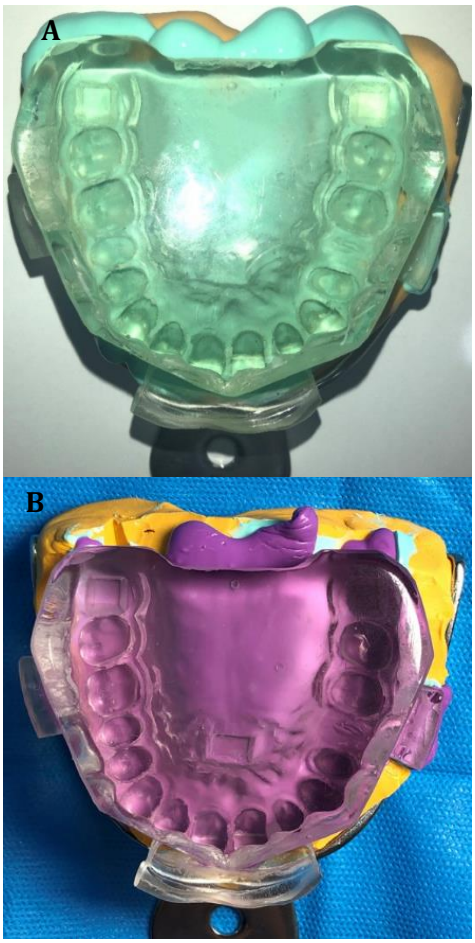

Fig. 2: (A) Putty-light body-addition silicone impression over the clear epoxy resin master model using a metal tray. (B) Putty-light body-extra-light addition silicone impression over the clear epoxy resin master model using a metal tray.

Master casts were made with type 4 dental stone (Tewerock, Kettenbach GmbH, Germany) which was mixed and poured under vacuum conditions (Automix, kooshafan pars, Tehran, Iran) according to the manufacturer's instructions [4,11]. The master casts and the master model were then scanned by a scanner (AutoScan-DS-EX Pro; Hangzhou, Zhejiang,

China) with <10 µm accuracy [3]. The master model was sprayed (Marmo Scan-Spray Basic; Siladent, Goslar, Germany) before scanning for transparency. Next, deviations in the accuracy of the master casts from the master model were quantified at the sites of prepared teeth using GOM Inspect software (GOM GmbH, Germany), and their point cloud differences were analyzed by calculation of the root mean square (RMS) [9].

For quantification of the differences in anteroposterior (AP) and cross-sectional (CS) dimensions, the scanned image of each master cast was superimposed on the scanned image of the master model using the three pyramidal-shaped indices as the superimposing reference points (Figure 3).

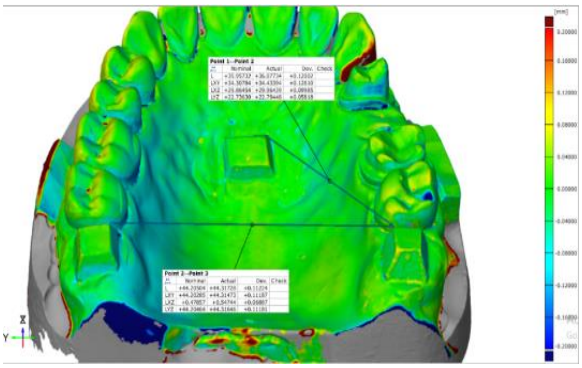

Fig. 3: Digital anteroposterior and cross-sectional measurements of a scanned master cast

The AP distances were measured from the mesiopalatal point angle of the pyramidal index at the site of left third molar to the left mesial point angle of the mid-palatal pyramidal index on both master casts and the master model. The CS distance was also measured from the mesiopalatal point angle of the pyramidal index at the site of left third molar to the mesiopalatal point angle of the pyramidal index at the site of right third molar on both master casts and the master model [10,11].

The data were analyzed using SPSS version 21. Normal distribution of data was ensured by the Kolmogorov-Smirnov test. The two-sample t-test was applied to compare the impression accuracy of the two groups at a significance level of 0.05.

RESULTS

Following comparisons with the master model as the reference, the results showed a mean difference in the AP distance of 0.0727±0.0398 µm and 0.0834±0.0322 µm for the 2-step and 3-step impression techniques, respectively. According to t-test, the AP difference between the two study groups was not significant (P=0.425).

The mean difference in the CS distance was 0.0997±0.0267 µm and 0.0573±0.0300 µm for the 2-step and 3-step impression techniques, respectively. According to t-test, the CS difference between the two study groups was statistically significant (P<0.001).

According to t-test, the mean RMS difference for the single-unit and multi-unit preparations between the two study groups was not statistically significant (P=0.095 and P=0.273, respectively).

DISCUSSION

Accurate impression making is among the most influential factors on the success and accuracy of single- and multi-unit fixed partial dentures. According to the present results, the null hypothesis of the study regarding no significant difference between the accuracy of 2-step (putty-light body) and 3-step (putty-light body-extra-light body) impressions was accepted. Moreover, the relined 2-step (3-step) technique showed higher accuracy as compared to the 2-step technique in terms of the CS distance. These findings highlighted that the 3-step impression technique could be as accurate as the 2-step impression technique and could potentially be used in certain situations. In addition to measuring the AP and CS distances digitally, the accuracy of the master casts at sites of prepared teeth was compared to the master model using the RMS, where lower RMS values indicate higher accuracy at each site of measurement [9,13, 14].

According to the present results, no significant difference was found between the two impression techniques in terms of the accuracy of single-unit preparations. Also, there was no significant difference between the two impression techniques in the

accuracy of multi-unit preparations which could mean that the 3-step technique might also be acceptable for short-span fixed partial denture preparations. Furthermore, no significant difference was found between the two impression techniques in terms of the AP distance, which could indicate that the 3-step technique might be suitable for long-span fixed partial denture preparations.

The present findings also showed a significant difference between the two impression techniques in terms of the CS distance, and the 3-step technique had a higher accuracy in this regard. It means that in making impressions for full arch prostheses, using the 3-step technique might possibly lead to more accurate results. To the best of the authors' knowledge, no previous study is available on the accuracy of the two methods used in the present study. However, some studies are available showing inaccuracies that were resulted from relining of second-step impressions due to using a different viscosity of impression material (light body instead of extra-light body) and also not considering the necessary additional space for the relining material [15,16]. Therefore, they concluded that making new impressions or complete relieving of the second step impression would be critical before relining with a light body material. The difference between the abovementioned studies and the present study lies in their smaller sample size (5 specimens per group), and also using light body impression material for relining. Furthermore, using the material to locally repair the imperfections alone would require excess force for correct seating of the impression in its correct original position. This could further increase the distortion of impression and result in smaller dies as well [8]. Moreover, the preparation design could have affected the results as the relined impressions had a higher accuracy at the shoulder margins in comparison to mesio-occluso-distal preparations [8]. Furthermore, it has been reported that although the dies made from relined polysulfide impressions were smaller in size as compared to the dies resulted from unrelined impressions, they were still more accurate because both dies were larger than the master die [7].

None of the previous studies investigating the accuracy of relined impressions by adding a third step used the extra-light viscosity of addition silicone impression material for this purpose. Also, they did not use a complete full-arch dental model to simulate the intra-oral conditions. Moreover, the accuracy of the master casts was measured digitally in the present study with a higher accuracy as compared to the traditional methods.

Although the results of the present study were promising regarding the relining of 2-step impressions with extra-light body addition silicone material, further studies are needed to evaluate the efficacy of this method in the clinical setting. One limitation of this study was using only one type of impression material in vitro. Other brands of impression materials with the suggested three consistencies should be tested in combination with different preparation designs before making any advice regarding their clinical use.

CONCLUSION

Within the limitations of this study, the results showed no significant difference in the accuracy of the 2-step and 3-step impression techniques using putty-light body and extra-light body addition silicone impression materials for single-unit and multi-unit preparations. The 3-step impression technique (putty-light body-extra-light body addition impression materials) showed a higher accuracy than the 2-step technique in terms of cross arch dimension.

CONFLICT OF INTEREST STATEMENT

None declared.

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