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ORIGINAL ARTICLE

CONTENTS

Himdani dual (heavy/light body) impression technique *(in vitro)* cross-sectional comparative study

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ABSTRACT

Aim: To evaluate the accuracy of the modified Himdani one-step impression technique compared with the conventional two-step technique.

Detailed objectives: To measure dimensional changes in each impression type;

To compare the effect of partial putty setting on the final impression accuracy;

To determine whether the scanning process influences dimensional measurements.

Materials and Methods: An *in vitro* design using 20 casts was employed in this study, comprising 10 casts from each of the two impression techniques. The two-step and modified single-step impression techniques were used in groups A and B, respectively. A putty was used for 1 minute of polymerization relined with light body on and around the teeth inside the putty impression. The putty was then re-seated until both were fully seated before removal. Each cast virtual model was superimposed on the arch virtual model using Exocad Dental DB software for matching. The buccal, lingual, mesial, distal, and occlusal aspects of both teeth 24 and 26, as well as the interabutment distance between the distal surface of tooth 24 and the mesial surface of tooth 26, were measured for each sample, revealing the maximum discrepancy in these nine areas.

Results: The modified one-step technique demonstrated significantly lower dimensional discrepancies across all measured surfaces compared with the two-step technique ($p<0.001$).

Conclusions: The modified technique demonstrated numerous advantages over the conventional technique, with greater accuracy in capturing dental impressions for dental prostheses. It was also simple and easy to apply in dentistry, which can replace the traditional impression technique.

KEY WORDS: conservative therapy, prosthesis fitting, dental materials, dental equipment, clinical-laboratory technique, impression accuracy, digital scanning

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INTRODUCTION

Restorative dentistry encompasses a broad range of clinical procedures, from simple conservative restorations to complex fixed prosthodontics treatment for tooth replacement [1-3]. One of the critical factors influencing the long-term success of restorations is the accurate reproduction of surface details of the prepared abutment teeth and the precise measurement of the distance between these teeth [4, 5].

Accurate registration can be achieved by meticulous impression taking. Impression procedure should consider the use of suitable impression material(s) [6, 7] and careful impression technique [8, 9]. Among elastomeric impression materials, addition silicone (polyvinyl siloxane) has been shown to exhibit superior accuracy, dimensional stability, and elastic recovery [10-12].

Two widely used procedures - one-step and two-step techniques. Both utilize heavy -body/light-body materials - are widely used in clinical practice. Each method, however, presents certain limitations. The one-step technique may result in inadequate wash space and localized pressure, while the two-step technique may produce discrepancies due to putty polymerization shrinkage and improper relief control [13, 14]. Despite multiple attempts to modify these techniques, the literature - particularly from Iraq remains limited regarding clinically applicable improvements that enhance impression accuracy.

AIM

Therefore, this study introduces and evaluates a modified one-step (Hamdani) impression technique. This evaluation aims to determine whether this technique can overcome the shortcomings associated with the conventional two-step method. The dimensional accuracy of this modified technique to be assessed and compared with the standard two-step approach for fixed dental prosthesis construction.

Detailed objectives:

1. To measure dimensional changes in each impression type;
2. To compare the effect of partial putty setting on the final impression accuracy;
3. To determine whether the scanning process influences dimensional measurements.

MATERIALS AND METHODS

This technique was suggested to reduce the need for a dental assistant during impression preparation, maximize the benefit of the setting time for the putty material, and, most importantly, save chair-time procedure (only material setting time). To test the author's hypothesis regarding its accuracy compared to the standard two-step technique, an in vitro, cross-sectional study design was employed as follows.

An upper arch model with plastic teeth (Prosthetic Restoration Jaw Model, Nissin, Kyoto, Japan) was used in this study (Fig. 1). Tooth 25 (maxillary left second molar) was removed, and its socket was blocked with flowable composite to simulate the extracted tooth area. Teeth 24 (maxillary left first premolar) and 26 tooth (maxillary left first molar) were prepared according to the guidelines to receive a three-unit fixed zirconia bridge.

Two impression techniques were used with the addition of silicon impression material to make ten impressions each group(n=10). The first technique was a two-step impression technique, in which the impression was made with putty that was mixed according to manufacturer's instructions and then loaded into the stock tray and seated onto the plastic model until it was fully set, then it was removed. The impression material was mixed according to the manufacturer's instructions. Plastic wrap was used as a spacer to create space for the light body. The light body was mixed with an automixing tip and injected around and over all teeth, including inside the set putty. Then it was re-seated on the model and waited until the set of light body was removed and poured into the stone cast. The second technique was a modified version of the single-step impression technique proposed by Dr. K. A. This technique involved using putty that was mixed and loaded into the tray, which was seated onto the plastic model and waiting for 1 minute (60 seconds) after the start of mixing to allow for partial setting and initial polymerization before removal to avoid permanent distortion. The putty was then removed with single vertical movement, and light body was immediately injected on and around the teeth, as well as inside the putty impression using a tray designed to ensure accurate reseating for the wash material. The piece was re-seated until both the putty and light body were fully set, after which it was removed.

All impressions were made using vinyl polysiloxane putty (Elite HD+ Putty Soft, Zhermack, Italy) and light body (Elite HD+ Light Body, Zhermack, Italy), and then poured using dental stone (Elite Rock, Zhermack, Italy). The setting time of impression materials recommended by the manufacturer was doubled to ensure proper setting at room temperature (23 ± 1°C) rather than 37°C as previously [18]. All impressions were kept at room temperature for 1 hour before pouring. Impressions were poured with IV dental stone (Elite Rock, Zhermack, Italy), which was mixed with a 20ml/100g water/powder ratio, and the cast was removed after 45 minutes according to the manufacturer's instructions and stored for 24 hours prior to digital scanning to ensure complete setting of the dental stone.

A total of 20 stone casts were obtained, 10 from each impression technique (n = 10). In Group A, the two-step impression technique was used. In Group B, the modified single-step impression technique was used.

An intraoral scanner (Trios 4, 3shape, Copenhagen, Denmark) was used to register a virtual model for the arch model and all the stone casts obtained from both impression techniques. All scans were performed by a single operator using identical scanning parameters to eliminate operator-related variability.

Each virtual cast model was superimposed onto the virtual master model using Exocad Dental DB software (version 3.0, Exocad GmbH, Germany) utilizing a global best-fit alignment based on an iterative closest point (ICP) algorithm [20].

Nine linear discrepancy measurements were recorded for each sample at the buccal, lingual, mesial, distal, and occlusal surfaces of teeth 24 and 26, as well as the inter-abutment distance between the distal surface of tooth 24 and the mesial surface of tooth 26.

The maximum discrepancy was defined as the largest point-to-point deviation detected among these nine measurement sites (Fig. 2).

To check the accuracy of the intraoral scanner used in this study and to negate any technical

Table 1. Maximum linear discrepancy (mm) for each measured surface of the prepared premolar and molar teeth obtained using the two impression techniques (n = 10 per group)

Surface & distance measurements	Technique	Minimum	Maximum	Mean	Std. Deviation	P value
Molar buccal surface	Modified one-step	0.049	0.461	0.1813	0.120147	0.043
Molar buccal surface	Two-step	0.113	0.859	0.3284	0.208612	
Molar lingual surface	Modified one-step	0.01	0.59	0.2526	0.171876	0.075
Molar lingual surface	Two-step	0.115	0.743	0.4414	0.199725	
Molar mesial surface	Modified one-step	0.021	0.09	0.0584	0.0255	0.143
Molar mesial surface	Two-step	0.026	0.589	0.1383	0.165189	
Molar distal surface	Modified one-step	0.031	0.23	0.1165	0.060612	0.190
Molar distal surface	Two-step	0.043	0.506	0.2062	0.15932	
Molar Occlusal surface	Modified one-step	0.027	0.323	0.1664	0.084217	0.089
Molar Occlusal surface	Two-step	0.032	1.043	0.3247	0.294915	
Premolar buccal surface	Modified one-step	0.029	0.244	0.1139	0.070622	0.063
Premolar buccal surface	Two-step	0.051	0.696	0.2429	0.194652	
Premolar lingual surface	Modified one-step	0.03	0.265	0.0804	0.069639	0.003
Premolar lingual surface	Two-step	0.05	0.513	0.232	0.153462	
Premolar mesial surface	Modified one-step	0.023	0.082	0.0429	0.019986	0.004
Premolar mesial surface	Two-step	0.036	0.347	0.1353	0.093539	
Premolar distal surface	Modified one-step	0.032	0.193	0.0861	0.051634	0.015
Premolar distal surface	Two-step	0.048	0.359	0.194	0.113426	
Premolar occlusal surface	Modified one-step	0.056	0.266	0.1156	0.06167	0.089
Premolar occlusal surface	Two-step	0.055	0.816	0.2211	0.21967	
Distance between abutments surface	Modified one-step	0.001	0.164	0.0636	0.050882	0.105
Distance between abutments surface	Two-step	0.006	0.292	0.1306	0.099376	

Notes: Maximum discrepancy was defined as the largest point-to-point linear deviation measured at each specified surface following global best-fit superimposition
Source: Compiled by the authors of this study

errors that might interfere with the results of this study, a second scan was made of the arch model after all scans of the casts. The virtual model obtained from the second scan was superimposed on the first scan. A Minimal deviation was observed between the two dataset was observed between these virtual models, indicating that the scanner did not affect the results (Fig. 3).

RESULTS

Table 1 provides the measurement details in millimeters for the maximum discrepancy in both techniques for each included surface in the measured teeth for the 10 samples per group. For the conventional two-step technique, the mean maximum discrepancy ranges from 0.10 to 0.40 mm The least discrepancy was found in the distance between the two prepared molar and premolar teeth, whereas the highest discrepancy was found in the lingual surface of the prepared molar tooth, almost 0.5 mm. Apart from the mesial molar surface, all premolar discrepancies in measurement were found to be less in the prepared molar tooth. In terms of surfaces, mesial surfaces in both prepared molar and premolar teeth were found with the least discrepancies.

On the other hand, the mean discrepancy for the measured surfaces in the modified single-step impression technique ranges from 0.06 to 0.59 mm. Similar to the conventional two-step impression technique, the highest measured discrepancy was found in the prepared lingual molar tooth surface. This was the same for the lowest recorded discrepancy. The distance between the prepared premolar and molar teeth was the least in the distance between two opposing prepared molar and premolar surfaces. Similarly, the two mesial surfaces of both prepared teeth showed the least discrepancy in terms of the prepared tooth surfaces.

The statistical difference in the level of discrepancy between the 10 samples for both techniques was found on the buccal molar surface, lingual molar surface, mesial premolar surface, and distal premolar surface. The difference between the two impression techniques was found to be highly significant on the lingual and mesial premolar surfaces.

Fig. 1. Maxillary arch model used for impression registration
Source: Own materials

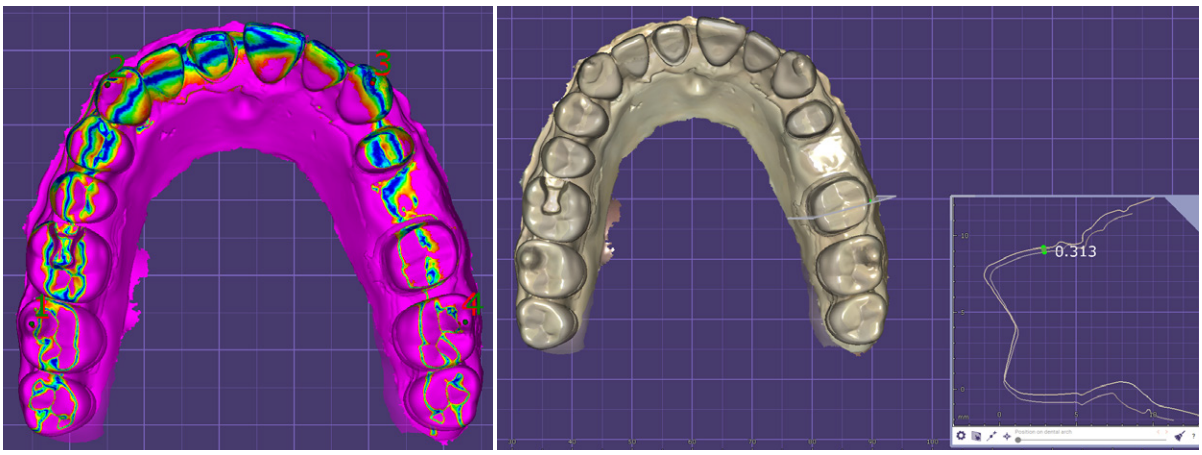

Fig. 2. Three-dimensional superimposition of a representative stone cast onto the virtual master model using global best-fit alignment. Color-coded deviation maps illustrate point-to-point linear discrepancies (mm) at the buccal, lingual, mesial, distal, and occlusal surfaces of the prepared premolar and molar teeth, as well as the inter-abutment distance
Source: Own materials

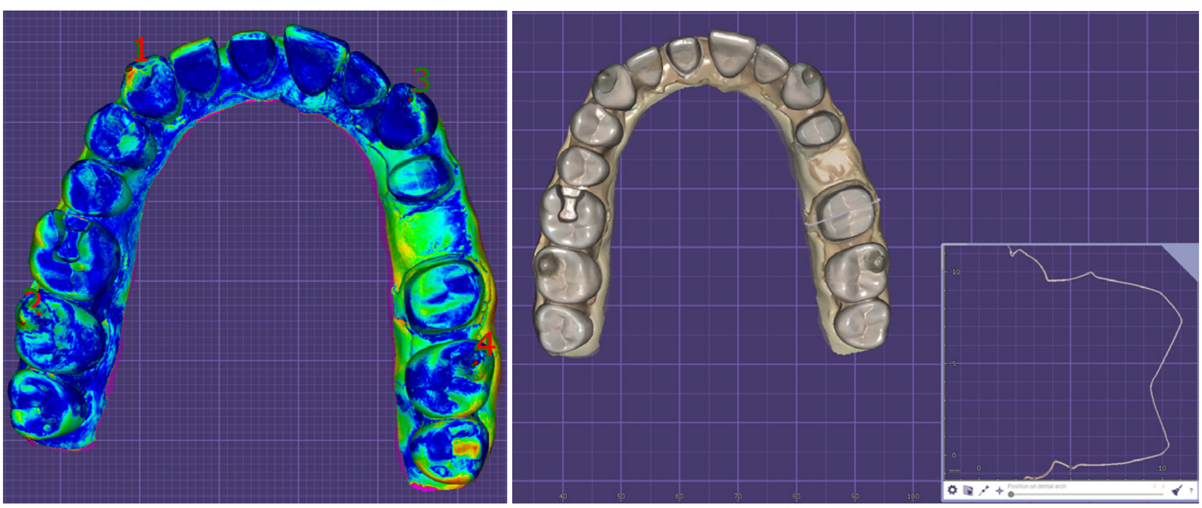

Fig. 3. Superimposition of two independent scans of the master model obtained using the same intraoral scanner and scanning protocol. Global best-fit alignment was performed using an iterative closest point (ICP) algorithm. The color-coded deviation map demonstrates minimal point-to-point discrepancies (mm), indicating high scanner repeatability
Source: Own materials

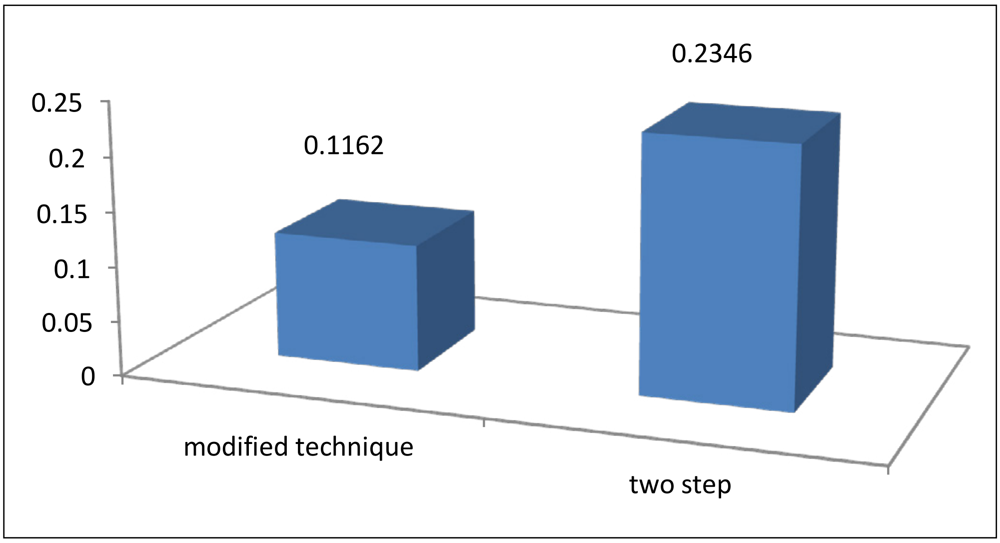

Fig. 4. Comparison of the mean maximum discrepancy (mm) between the modified one-step and conventional two-step VPS impression techniques across all measured premolar and molar surfaces (n = 10 per group). Error bars represent standard deviation. A statistically significant difference was observed between the two techniques ($p < 0.001$)

The overall difference between the modified single-step and two-step techniques is shown in Figure 4. The mean discrepancy degree in the modified one-step technique for the 10 samples, involving all molar and premolar surfaces, is less than that of the conventional two-step technique. This difference has been statistically significant ($P < 0.001$).

DISCUSSION

The current in-vitro study evaluated the accuracy of applying the two-step and modified one-step putty/light body impression techniques. Both of these techniques require two-handed work in a clinical setting. This may justify the comparison of the modified one-step technique with the two-step technique. The results showed a higher accuracy for the modified one-step impression technique. A several explanations may account for this improved technique:

First, in the modified one-step technique, the putty impression acts as an accurate special tray, which leads to equal pressure throughout all parts of the impression, especially for the critical details in the sulcus area, resulting in sound diffusion of light body material. In contrast, with the two-step technique, the thickness of the light body cannot be control, as the plastic wrap can fold and create uneven spaces necessary for the diffusion of the light material. This uncontrolled gap results in unequal and/or insufficient pressure, which is necessary for the diffusion of light materials. These tiny, important details are still behind the lower inaccuracy of the two-step impression technique [1].

Second, in the modified one-step method, the light body was injected prior to the whole setting of the putty. This procedure will enhance the adhesion of both components and reduce the likelihood of sloughing of the light body from the putty, which is not uncommon in the two-step technique, especially if the putty was contaminated before the application of the light body.

Third, another possible cause is that in the two-step technique, the putty was re-seated after it was fully set. This may prevent or interfere with the full seating of putty as it gains some hardness, especially in interdentally and undercut areas, reducing the pressure needed for light body spread. On the other hand, in the modified one-step technique, the putty remained unset and possessed adequate softness, allowing it to be re-seated appropriately.

In previous studies, comparisons between two-step and one-step techniques have been conducted, although some studies reported no difference in accuracy [15-23]. Other studies, however, concluded that two-step techniques were more accurate than one-step techniques [16-19]. Most of the dimensional changes occur due to polymerization shrinkage of the impression material, which is particularly pronounced in the putty step, as it has a greater mass than the light body. That is why the two-step technique showed higher accuracy, as the putty was allowed to be set prior to the light body, which compensates for most of the shrinkage that occurred. While in one step, there is no chance for the light body to compensate for putty shrinkage as it is both used simultaneously, besides that, there is the possibility that some details will be registered by putty only as the light body might be washed out. However, the results of the current study showed that the suggested (modified one-step technique) provides more accurate results than the two-step technique.

To the best of the authors' knowledge, this is the first study to examine the dimensional accuracy of modified one-step technique. The modified one-step technique allowed for a partial setting of putty with concomitant shrinkage before light body application, compensating for sufficient shrinkage. Rocking and removal of putty while it is still soft will create a space for a light body, reducing the possibility of being washed out during re-seating. In addition, re-seating still soft putty could result in better adaptability than fully set putty.

LIMITATIONS

This study was conducted in vitro and therefore does not account for intraoral variables such as saliva, blood, tissue movement, patient cooperation, or temperature variations, all of which may influence clinical accuracy. Future clinical studies are needed to validate these findings in real patient settings.

CONCLUSIONS

Within the limitation of this in-vitro study, the modified one-step putty/light body impression technique was presented in this study. It demonstrates several advantages over the conventional two-step impression technique and shows lower maximum dimensional discrepancy in capturing dental impressions. The modified one-step approach may offer a feasible alternative impression technique under managed conditions. However, clinical (*in-vivo*) studies are required to confirm these findings and to impact influence of intraoral factors on impression precision before routine clinical application can be recommended.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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