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COMPARISON OF LINEAR DIMENSIONAL ACCURACY BETWEEN ONE STEP AND TWO-STEP IMPRESSION TECHNIQUE

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Abstract:

Introduction: It is particularly in restorative dentistry, where the first and most accurate impressions are essential in formulating dental prostheses. The objective of this research is to evaluate the level of linear dimensional accuracy for the one-step and the two-step impression techniques using the polyvinyl siloxane (PVS) material.

Objectives: The study aimed to assess the one step and two step impression techniques in terms of linear dimensional accuracy using polyvinyl siloxane material.

Materials and Methods: Consequently, the present cross-sectional study was conducted at the Dentistry Department, Ayub Medical College Abbottabad, Pakistan, from 1st June, 2024 to 30th November 2024. A total of 30 participants were selected according to specific criteria. The two impression techniques for this study were one-step and two-step, using PVS material, and the linear dimensional accuracy was measured in three reference points. To compare the results between the two techniques, the results were subjected to paired t-tests.

Results: The outcomes demonstrated that there were little differences in the model's linear dimensional accuracy between the two approaches. Additionally, although the variation was not significantly different, the one-step method was slightly more precise than the other approaches.

Conclusion: The outcome of the one step and two step impression procedure using the PVS material was in quite close agreement with each other.

Keywords: precision of dimensions, Polyvinyl siloxane Impression material, one-step and two-step techniques, Dental prosthetics.

INTRODUCTION

Maximum impression accuracy is crucial for prosthetic restorations. Among all materials commonly used in dental impression techniques, Polyvinyl Siloxane (PVS) is considered the material of choice due to its desirable properties, such as high dimensional stability and excellent surface detail reproduction (1). They are used in one-step and two-step methods of making soap, including potassium hydroxide for making hard soap. With these impression techniques, the PVS material is used so that the oral structure duplicates the expectancy in various prosthodontic procedures, crowns, bridges, and implants. The one-step and the two-step methods are the two most common techniques, and while the methods may vary slightly in how they are executed, both try to maximize the degree of accuracy in impressions. Some research has been conducted on the dimensional accuracy of PVS impressions under various conditions and methods. Ghanem (1) pointed out that dimensional accuracy is one of the key features of PVS due to the requirement for implant impressions to be accurate. This was supported by Khare et al. (2) in their study on comparing different impression materials and methods, where they mentioned that PVS types always produced high dimensional accuracy compared to other elastomeric impression materials.

Nevertheless, it would be crucial to understand that pouring time and storage conditions also have an impact on PVS and that PVS is not perfect. The two-step impression-making is a method that has been widely taught and implemented in many clinical environments where an initial impression is taken, followed by a more detailed impression (3). Comparing the dimensional accuracy of various impression materials, Elkawash et al. (3) also found that the CBCT, the two-step method, gives more vigorous and more accurate results than the one-step method. Nonetheless, they also imply increased complexity and longer time for the overall procedure as it became a two-step process. Özsoy et al. (4) also noticed that the pouring time affected the dimensional accuracy of impressions, which needs to be considered when comparing the accuracy of the two methods. Therefore, the two-step method offers higher accuracy, but it may not be feasible or practical in some clinical settings. However, this method was found to be faster and more convenient than the two-step technique, the accuracy produced by this method was not always as high as the accuracy obtained by the two-step technique. As Pokharkar et al. (5) pointed out, the one-step method may not be sufficiently accurate for specific applications, especially those demanding high accuracy, like implant impressions. Roberts supported this (6) and observed that dimensional stability may diminish over time on PVS impressions, particularly where multiple pourings are made. In addition, there was a reduction in finishing time due to the straightforward, quick and comfortable application of the one-step technique, which Sayed et al. (7) observed through their finding, yet the method had certain disadvantages in final casts, such as inaccuracy more than the multi-step impressions technique. Recent developments in impression-taking have also been covered, particularly digital impression-taking. Singer et al. (8) examined the characterizations of various generations of elastomeric materials, including PVS, and established that digital techniques may provide similar, if not superior, performance. However, these technologies are not readily available across clinics, especially in developing countries like some regions of Pakistan. Bhatia et al. (9) pointed out that despite most of the merits of using digital impressions, the traditional method of making impressions, including PVS, are widely in use due to their efficiency and reliability. In their work, Apinsathanon et al. (10) evaluated the penetration and tensile strength of different elastomeric materials to conclude that PVS is superior to other materials, particularly in terms of fine details restoration ability, which could be done either in one or two-step technique. However, the perfectionism in capturing this detail depends on the competency level of the clinician and the context under which the impression is made. Zappi et al. (12) indicated that the modified two-step technique with a wiggling motion might provide comparable results to other traditional methods, even as it simplifies the process. It is also vital for the materials to be more impression-accurate in that they do not fade with time. Abdelhameed et al. (11) mentioned that PVS and other addition silicones are also affected by the change in the dimensional stability associated with the disinfection process. This emphasizes the need to regulate these factors when taking impressions in clinical situations to achieve the required cast dimensions (13). Moreover, Suwanwalaikorn and Aimjirakul (15) have examined

the penetration ability of multiple elastomeric materials; this underlines the choice of the impression material that is suitable for specific clinical requirements.
Finally, the one-step and two-step impression techniques with PVS material are commonly used in dental prosthodontics. Both are effective, but their limitations are also there. As such, the effectiveness of these techniques depends on the kind of material used and other factors such as the pouring time and certain clinical situations. Although the two-step method is more accurate than the one-step method, the latter is fast and easy to apply. More research is required to reveal other chemicals that could be used to increase the level of precision of impressions as well as shorten the steps needed for the impression-taking process.

Objective: The objective of this study is to compare the linear dimensional accuracy of one-step and two-step impression techniques using polyvinyl siloxane impression material, evaluating their effectiveness in achieving precise impressions for dental applications.

MATERIALS AND METHODS

Study Design: This research used an experimental, comparative research design to assess the validity of the linear dimensional accuracy of two impression methods one-step and two-step impression techniques using Polyvinyl siloxane material. The comparison shall be done based on the final cast dimensions that has been acquired through the two techniques.

Study setting: The study was done at the Dentistry Department, Ayub Medical College Abbottabad, Pakistan. This hospital has well-equipped dental health facilities and is differentiated for clinical research.

Duration of the study: This study was carried out from 1st June, 2024 to 30th November, 2024.

Inclusion Criteria:

The inclusion criteria was participants between 20 and 50 years old, have intact dental arches, have no signs of periodontal diseases and malocclusion, and have not received any dental treatments within the past year. Informed consent of the patient to be included in the study was considered with the signed consent forms only.

Exclusion Criteria

Consequently, partially edentulous individuals with periodontal disorders or requests for dental treatments, such as implants, crowns or bridges, was excluded from the study. Also, patients with an allergic reaction towards polyvinyl siloxane materials or individuals who cannot adhere to the study procedures was not participated in the study.

Methods

In general, 40 patients was included in this study using the inclusion and exclusion criteria. The one and two-step impression procedures was made using the polyvinyl siloxane (PVS) impression material, and each participant have their impression taken. The impression was made with PVS material during this single appointment using the one-step technique.

On the other hand, the two-step technique require creating an impression in the first appointment and then another in the second. Once the impressions are made, the casts was poured using type IV dental stone. These was done using a digital calliper on specific landmarks such as the mesiodistal width of the first molar, the inter-canine distance, and the arch length. The details of the questionnaires was handled using statistical analysis to compare the efficiency of both techniques.

RESULTS

A total of 40 participants were selected for the study and combined into two equal groups by random sampling method. Therefore, one-step and two-step impression procedures using polyvinyl siloxane (PVS) material were applied to each participant. To know the extent of linear dimensional accuracy of these casts, measurement was made, and the results of both techniques were compared.

Demographics

Table 1 presents the demographic data of the participants. The participants were 20 years and above, and the mean age of the participants was 35.6 years. In a gender perspective, 60% of the respondents were male and the other 40% were females.

Table 1: Demographics of Study Participants

Demographic Variable	Number of Participants (n=40)	Percentage (%)
Gender		
Male	24	60%
Female	16	40%
Age Range (years)		
20-30	10	25%
31-40	14	35%
41-50	16	40%

The linear dimensional accuracy was assessed at three points mesiodistal width of the first molar, the distance between the canines, and total arch length. The features of both techniques are summarized in Table 2.

Table 2: Linear Dimensional Accuracy for One-Step and Two-Step Techniques

Measurement Point	One-Step Technique (mm)	Two-Step Technique (mm)	p-value
Mesiodistal Width of First Molar	22.5 ± 0.2	22.6 ± 0.3	0.278
Inter-canine Distance	28.4 ± 0.3	28.5 ± 0.4	0.201
Arch Length	70.1 ± 0.4	70.3 ± 0.5	0.156

The discovery indicated that both techniques performed the test of dimensional accuracy at the reference point with similar results. All the measurements had ‘P’ values more than 0,05, meaning no significant difference exists in the accuracy between the two techniques. In Table 3, the overall performance of the casts obtained from both techniques in terms of the average deviation from the reference dimensions is presented.

Table 3: Overall Dimensional Accuracy of Impressions

Impression Technique	Average Deviation (mm)	Standard Deviation (mm)
One-Step Technique	0.35	0.09
Two-Step Technique	0.37	0.10

The percent deviation from the reference dimensions was slightly lesser for the one step technique than the two step technique, but the difference in value was quite close. Both techniques were observed to be precise in terms of dimensionality, with negligible variations from the base measurements. The outcomes support that the linear dimension precision of the one-step and two-step impression techniques are similar and identical when using polyvinyl siloxane material. It has also been established that both methods are pretty effective in casting procedures with satisfactory results for prosthesis use.

DISCUSSION

The study showed that both methods provided highly accurate impressions, and any small disparities in the linear dimensional accuracy of the casts were negligible. The result of the study provides evidence that both these techniques can independently be applied in a clinical setting to obtain accurate casts for dental restorations. However, it is crucial to examine how these outcomes were achieved and how they compare to prior research to evaluate the practical implications of these observations. The degree of linear dimensional accuracy was assessed at three positions, mesiodistal width of the first molar, inter canine distance and arch length. All these measurements are clinically relevant because they reflect the fit and performance of the prosthetic restorations, such as crowns, bridges, as well as complete and partial dentures.

In both the one-step and two-step techniques, the average deviations at these points were assessed to be minimal, highlighting that both methods can offer accurate impacts that depict the geometric measurements of the mouth. This is in consonant with the earlier research of Ghanem (2024) and Khare et al. (2024), who noted that PVS materials have great accuracy in the detailed impressions of various structures in the oral cavity regardless of the impression-taking technique used. Other research by Zappi et al. (2023) examined the factual accuracies of different impression techniques and concluded that one-step and two-step approaches did not differ when employing elastomeric materials. The study by Özsoy et al. (2021) also showed that pouring time and handling of PVS material does not directly affect the dimensional accuracy of the impressions.

This could be because the principles of these two techniques involve capturing the dental structures into the impression material, and both methods are considered highly accurate. As for the overall performance, both techniques perform similarly, but the one-step technique has a slightly lower average deviation than the two-step technique. This may be attributed to the fact of eradication of the possibility of distortion, which may occur in the intermediate step of the two-step techniques, where the impression material is exposed to environmental factors such as humidity and temperature during the waiting period between the first and second impressions (Pokharkar et al., 2021). However, this difference was less than one hundred micrometres, and the clinical implications of such a slight variation in dimensional stability are doubtful because it remains within the allowable error margin usually allowed for dental prosthetics.

It is essential to identify these parameters, and the clinical implications of such issues are crucial for dental practitioners since both the one-step and two-step impression techniques are frequently used in practice. The choice of which method to use may go down to factors like the comfort of the patient, a complex case, or the amount of time available. Since both techniques show high accuracy, clinicians can incorporate either of the methods in their work without a decrease in accuracy. This agrees with Eldakar et al. (2025), who pointed out that the PVS impression materials were accurate for all the techniques and materials. In addition, the concordance with the dimensional accuracy of this study between the two methods is further evidenced by the findings on PVS materials in the literature.

Roberts (2021) and Sayed et al. (2021) have established that, without distortion, PVS materials have shrunk or expanded minimally while making impressions, which makes them highly suitable for creating accurate impressions. It is noticed that the one-step and the two-step impressions have minimal dimensional discrepancies, which indirectly asserts the PVS material's stability and reliability regarding its clinical application. It is necessary to mention that there are more decision-making factors concerning the impression technique, such as the possibility of capturing details on the given surface and managing the working material. Earlier researchers have established that the surface detail reproduction capability of PVS materials is higher than that of other elastomeric materials (Bhatia et al., 2023).

In addition, the properties of PVS materials that flow well and conveniently into the gingival sulcus and their low shrinkage factor make them ideal materials for use in one-step or two-step techniques (Singer et al., 2022). Looking at the practical aspects, the one-step approach has certain advantages, especially in terms of time, as it is less time-consuming and fewer visits are needed overall, besides being quicker to complete. This could be helpful specifically in a clinical environment when time may not be on the side of the adopting practitioner. However, the two-step technique is a little longer.

Other pros may be connected with complicated situations, such as large edentulous areas and implantology prosthetics requiring several impressions. One method may be preferred over the other based on the patient's conditions and the clinician's experience and judgment.

Lastly, one-step and two-step impression techniques using polyvinyl siloxane material showed an equal amount of linear dimension movements in this study. The similarities in details of the two methods indicate that three basic hand gesture rehabilitation techniques are alike and can be interchanged in clinical practice. These findings do not contradict the existing material as they advocate using PVS materials to take dental impressions. Therefore, depending on factors such as patient preference, complexity of the case, and time constraints, it would be more relevant to prefer one over the other than citing dimensional accuracy as a basis for the choice.

CONCLUSION

Lastly, it was concluded that both one-step and two-step impression techniques employing polyvinyl siloxane material yield the most accurate linear dimensional measurement. Consequently, both techniques are equally valuable for clinical practice, and no significant impact on the accuracy of dental casts has been observed when one of them is used instead of the other. A slightly higher dimensional stability of the one-step technique may suggest this is a more time-effective solution for treatment delivery in a busy clinical practice. Still, both methods gave acceptable values for all quantified parameters, as illustrated in the literature regarding the reliability and stability of polyvinyl siloxane materials. Thus, other than the examples mentioned above, the choice between the two techniques should be based on the degree of patient comfort, complexity of the case and time available and not on dimensional accuracy. Therefore, the results of this study would add to the clinical relevance of polyvinyl siloxane impression material in restorative dentistry.

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