

COMPARISON OF LINEAR DIMENSIONAL ACCURACY BETWEEN ONE STEP AND TWO-STEP IMPRESSION TECHNIQUE USING POLYVINYL SILOXANE IMPRESSION MATERIAL

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ABSTRACT

OBJECTIVES

This study compares the linear dimensional accuracy between one step and two-step impression techniques using polyvinyl siloxane impression material.

METHODOLOGY

The Randomized controlled trial was done in the Department of Prosthodontics, FMH College of Medicine and Dentistry Lahore and Pakistan Council for Science and Industrial Research Lahore. All impression samples which fall under the inclusion criteria in the Department of Prosthodontics, FMH College of Medicine and Dentistry Lahore and Pakistan Council for Science and Industrial Research Lahore were included. Samples were divided into two groups, i.e., Group 1 (single-step technique) & Group 2 (two-step technique). The impression's longitudinal length and inter-line distance were measured to assess the outcome i-e linear dimensional accuracy.

RESULT

A total of 60 impression samples with polyvinyl siloxane impressions material were made. The linear dimensional accuracy in one step & two-step impression technique was seen in 5 (8.33%) & 13(21.66%) samples, respectively, ($p=0.011$).

CONCLUSION

Compared to the one-step impression technique, the higher linear dimensional accuracy of the two-step impression technique uses polyvinyl siloxane impression material.

KEYWORDS: *Impression technique, linear dimensional accuracy, Additional silicon, polyvinyl siloxane*

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INTRODUCTION

A precisely made dental impression is a prerequisite for successful fixed dental prosthesis fabrication and is directly dependent on the dimensional stability, accuracy and flexibility of the impression materials and the appropriately used impression techniques.¹ Dental impression making remains a challenging procedure due to the potential for voids and tears, which may adversely affect the precise fabrication of indirect

restorations.² To overcome these problems, dental manufacturers have developed elastic impression materials capable of acceptable accuracy in clinical use. There are several elastic impression materials available for dental use. Synthetic elastomeric polymers, including polysulfide, condensation silicone, addition silicone (polyvinyl siloxanes) and polyether, are among the materials most used to make impressions of various areas of the dental arches. The addition-type silicones have the best surface reproduction and elastic recovery of all available impression materials. They have achieved a high level of the dentist and patient acceptance, as they are clean, odorless, and tasteless. In addition, polyvinyl siloxanes possess outstanding dimensional stability because they are not vulnerable to humidity changes and do not release any by-products.³ The PVS impression materials have low dimensional changes, low creep, relatively short setting time, and moderate to high tear resistance. As there are no by-products to the polymerization reaction, impressions are dimensionally stable and can be poured at the operator's convenience.⁴ Impression techniques with PVS impression material can be categorized as single-step putty/light-body techniques or two-step putty/light-body techniques. In the single-step technique, putty and light-body polymerize simultaneously, reducing chair side time and saving impression material.⁵ While in the two-step technique, putty is first used alone as the initial step, and the final impression is made within the tray of putty material by use of light-body silicone. In the literature, some authors favor the accuracy of the single-step technique; some recommend the two-step technique, and some suggest that there is no difference in the result of the single-step and two-step techniques. A study conducted with a single-step impression is more dimensionally accurate than the two-step impression technique in conjunction with PVS impression material ($P < 0.01$).³ Another study concluded that the two impression techniques showed a better result (double impression = 0.43% difference) compared with the single impression technique (single impression = 0.71% difference) ($P = 0.02$).⁴ As there are conflicting results of different studies relating to the accuracy of impression technique, which may be because these studies would not control the confounding variables, for example, the water powder ratio of dental stone used for fabrication of abutments dies, impurities present in the powder of dental stone, the humidity of surrounding while working with dental stone. This study aims to compare the

dimensional accuracy of two versus single-step impression techniques, with controlling the confounding factors (so that these variables cannot affect the study results), in the local clinical setup for better reproduction of accuracy and details of the final impression for a permanent prosthesis.

METHODOLOGY

A randomized-controlled trial was conducted at the Department of Prosthodontics, Fatima Memorial Hospital College of Medicine and Dentistry Lahore and the Pakistan Council for Science and Industrial Research Lahore. The non-probability consecutive sampling technique was used for selecting the sample. The sample size was 60 (30 in each group) is calculated at a 5% level of significance, and 90% power of the test and taking expected frequency of accuracy in one step group is 0% in longitudinal length and 100% in two-step group. The inclusion criteria were complete set on samples of addition silicon which are challenging, elastic and do not show stickiness when checked with gloved hands and well-made impressions having no voids, tears and would have recorded the mold surface smoothly by seeing with naked eyes. Samples having defects (voids, tears or unset), inaccurate impressions due to defective material, and blowholes were excluded. A custom milled brass mold was fabricated according to ADA specification number 19. This mold consisted of the Ruled Block, the Die Ring and the Spacer. The ruled block was a circular metal block of 29mm in diameter, the height of 45mm, having three straight lines in the centre. The lines are marked as a and a', b and b's, c and c'. Each line is 25mm in length. These lines are 2.5mm apart from each other. The die ring is 29mm in diameter and 8mm in height. This ring was placed over the ruled block before impression making. The spacer is a brass plate 0.5 mm thick and 29 mm in diameter. The specimens (Fig 1 and Fig 2) will be divided into two groups; Group 1 (The impression samples of the single-step technique) and Group 2 (The impression samples of the two-step technique)

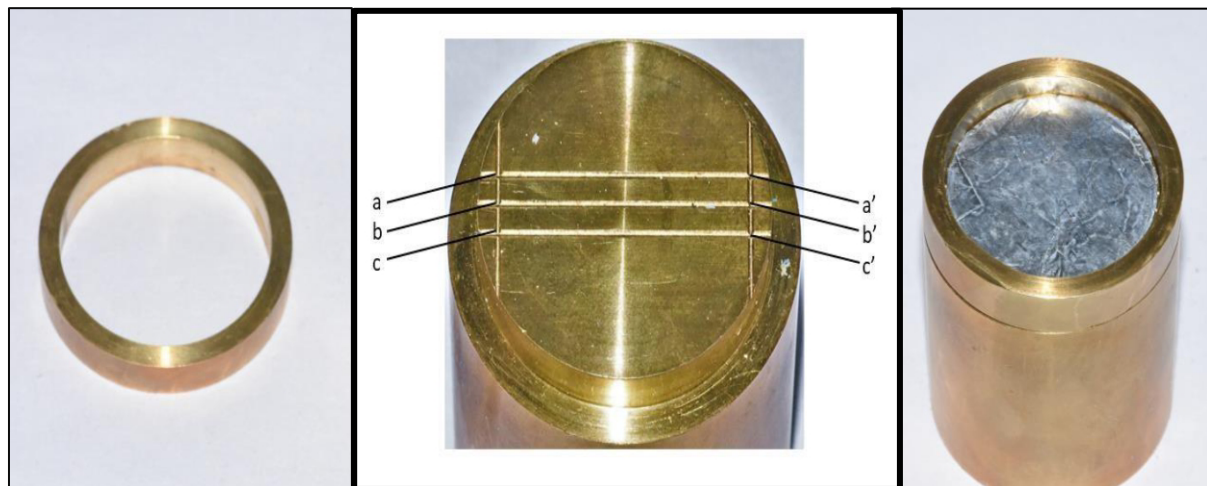


Fig: 1 (A) The die Ring (B) The Ruled Block (C) The spacer overruled block with the ring placed

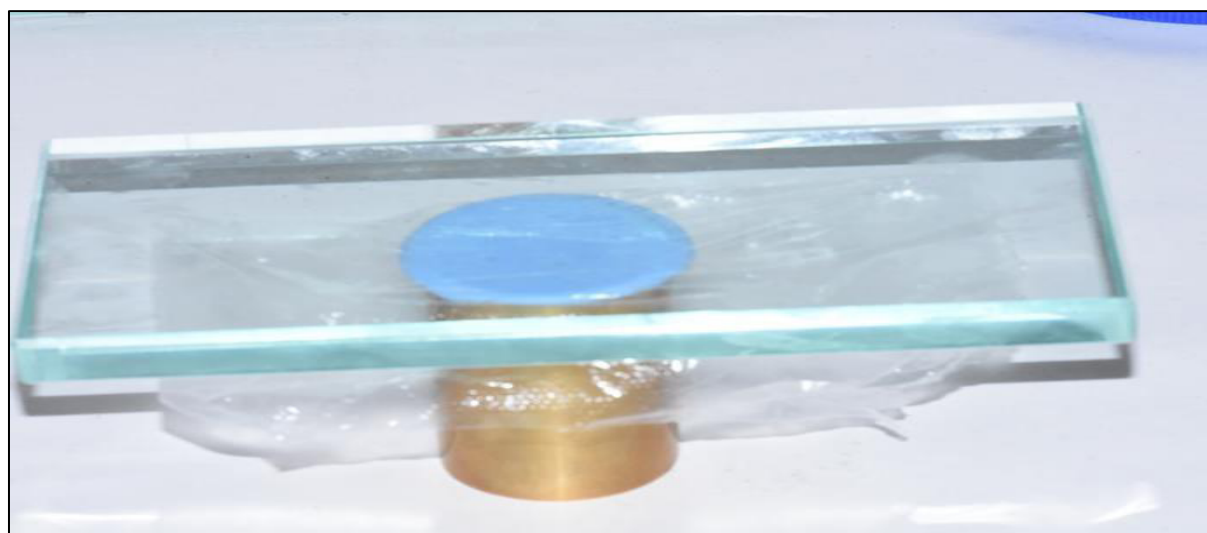


Fig.2: A flat glass slab placed on top of a mold separated by a polyethylene sheet

In the single-step technique, parts A and B were assembled together. Light-bodied PVS impression material was loaded in a fine-tipped impression syringe and was applied on the lined areas of the ruled block, and the die ring was used to confine the material. Then heavy-bodied PVS impression material was placed over the light body. A flat glass slab was placed on the mold, separated by a polyethylene sheet. A 500gm weight was placed over the glass slab to ensure constant pressure over the mold for 13 minutes. The whole assembly was immediately transferred to the thermostatically controlled water bath. The temperature was maintained at 37°C to simulate oral conditions (ADA specification number 19). After assembling parts A and B in the two-step technique, the brass plate spacer was placed in the mold (to create uniform space for light-bodied impression

material). A flat glass slab was placed on the mold, separated by a polyethylene sheet. A 500gm weight was placed over the glass slab to ensure constant pressure over the mold for 13 minutes. The heavy-bodied PVS was allowed to be set in the thermostatically controlled water bath. (fig.3,4 and 5)



Fig.3: A 500 gm Weight Placed on the Top of a Glass Slab

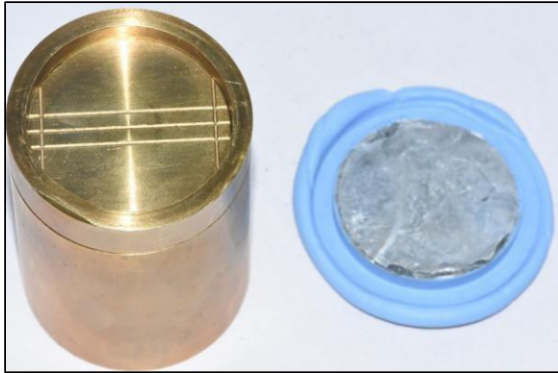


Fig.4: Putty Impression with Spacer

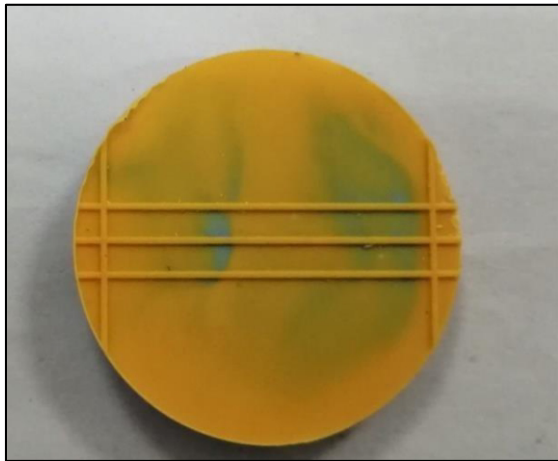


Fig.5 One - step Impression Sample



Fig. 6: Two-step impression sample

When the heavy-bodied had set, the spacer was taken out, and the light-bodied PVS was applied with an impression syringe on the lined areas of the mold. Then the set of heavy-bodied PVS was placed over the light-bodied and covered with a polyethylene sheet. The flat glass slab was placed

over the mold; a 500 gm weight was placed on the top of the glass slab to maintain constant pressure. The excess material was an escape from the sides of the die ring. The assembly was transferred to a thermostatically controlled water bath, maintaining a temperature of 37°C. The entire assembly was removed from the water bath after 13 minutes. The impressions were allowed to be set for 5 minutes longer than the manufacturers recommended minimal removal time, according to the ADA specification Number 19 for laboratory testing. The mold and the die ring were then separated to retrieve the impressions. (Fig. 6, 7)

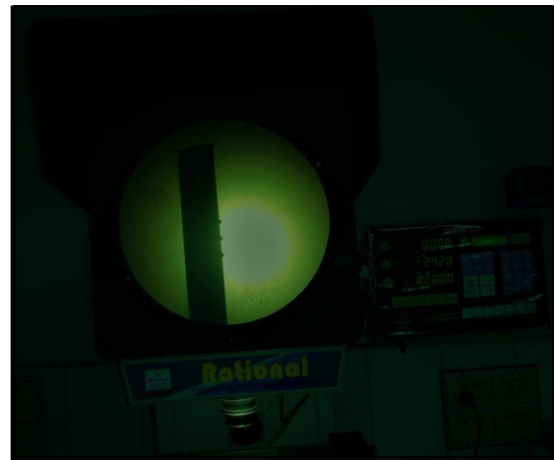


Fig.7: Impression Sample Measuring Under Profile Projector

The linear dimensional accuracy of samples of both Groups was evaluated 24 hours (PVS show outstanding dimensional stability after complete evaporation of hydrogen gas) after impression making. The length of the lines and the distance between these lines were measured using a Profile Projector (a type of microscope which measure the length of the recorded lines and the distance between the lines of the impression samples) fig.9. The samples in which the lines were nearer (in length) to the standardized mold were labelled as accurate, and other samples which were either larger or smaller than the standardized mold were labelled as inaccurate samples. The data was entered and analyzed in SPSS version 25.0. Qualitative or categorical variables were presented in the form of frequency and percentages. An independent sample t-test was used to see a statistically significant difference between Group 1 and Group 2, and $P < 0.05$ was considered significant.

RESULT

60 samples were divided into Group-I, single-step

impression technique, and Group-II, two-step impression technique. The groups were further categorized into two subgroups. Subgroups were divided based on the range of measurements;

Subgroup A had a range of 21-24.29 mm, while subgroup B had a range of measurement of 24.30-25.00 mm.

Table 1: The Longitudinal Length between Points a to a', b to b' and c to c'

		a-a'	b-b'	c-c'
Group – I	Subgroup A	23(38.33%)	14(23.33%)	17(28.33%)
	Subgroup B	7(11.66%)	16(26.66%)	13(21.66%)
Mean longitudinal length		23.4233+1.15122	23.9900+1.05384	23.8600+0.95506
Group – II	Subgroup A	12(20%)	12(20%)	12(20%)
	Subgroup B	18 (30%)	18(30%)	18(30%)
Mean longitudinal length		23.9867+0.96686	24.0950+0.95596	24.0750+0.84535
T-test		0.165	-0.271	0.223
P-value		0.870	0.788	0.825

Table 2: The Inter-Lines Distance between a to b, b to c, a' to b' and b' to c'

		a-b	b-c	a'-b'	b'-c'
Group – I	Subgroup A	12(20%)	20(33.33%)	13(21.66%)	17(28.33%)
	Subgroup B	18(30%)	10(16.66%)	17(28.33%)	13(21.66%)
Mean Inter-lines distance		2.2033+0.23191	2.1533+0.20675	2.1767+0.17798	2.1867+0.19997
Group – II	Subgroup A	14(23.33%)	14(23.33%)	15(25%)	12(20%)
	Subgroup B	16(26.66%)	16(26.66%)	15(25%)	18(30%)
Mean Inter-lines distance		2.1583+0.19612	2.1633+0.19737	2.2050+0.19885	2.2083+0.18340
t-test		0.083	-1.058	0.609	-1.402
P value		0.935	0.299	0.548	0.172

Table 3: Linear Dimensional Accuracy Distributions with Respect to Groups

Linear Dimensional Accuracy	G-I	G-II	Overall	P-Value
Subgroup A	25(41.66%)	17(28.33%)	42(20%)	0.011
Subgroup B	5(8.33%)	13(21.66%)	18(30%)	
Total	30(50%)	30(50%)	60(100%)	

DISCUSSION

The retention of a fixed partial denture depends on the tensio-frictional resistance developed between the surface to surface contact of the inner surface of casted crowns and the outer surface of the prepared teeth in extra-coronal type retainer. The accurate reproduction of prepared teeth is paramount to the success of fixed partial dentures.^{6,8} Polyvinyl siloxane (PVS) is the current choice of impression material for accurate reproduction of prepared teeth used either with one step technique or two-step impression making technique.⁷ The dimensional accuracy of these impressions was determined in this study. In Group-I, The linear dimensional accuracy in one step impression technique was noted in 5 samples (8.33%), while in the two-step impression technique (group-II), it was noted in 13 samples (21.66%); hence the hypothesis has been proved correct that two-step impression had a significant effect on the dimensional accuracy of polyvinyl siloxane impression material. In the literature, studies have been conducted and reported that impressions

made with the double step technique have higher linear dimensional accuracy. The researcher concluded that multiple mixes are better in the monophasic technique.¹⁰ In two different studies, it was summarized that the double-mix procedure increases impression accuracy and reduces the distortion during storage.^{11,12} The superiority of the multiple mixes over a single mix is probably due to several factors. When the partially set putty material in the tray is seated, it will displace much of the injected light-body material. The tray material undergoes a more significant amount of curing shrinkage, thus resulting in a less subsequent change in the critical region of the impression. Likewise, the material compresses the injected material and thus eliminates many air bubbles trapped within the material and between the material and the tooth. In addition, compared the accuracy of polyvinyl siloxane impression materials made from single mix putty/wash, double-mix with 2 mm relief space and double-mix with polyethylene spacers.¹² They found that the double-mix with 2 mm relief putty/wash impression technique was the most stable and

produced the most accurate model dies, supporting the current study. The difference in the single mix and double-mix in accuracy and elasticity may be attributed to the polymerization rate: Faster polymerization will prohibit the penetration of the free radicals. The light-body component occupies a minute volume, so its effect on the resultant deformation will be slight.¹³ Vinyl polysiloxane impression materials are available in all viscosities: Light, medium, heavy, and putty. Studies have shown that higher filler loading may increase the accuracy and viscosity, less the constriction. And low viscosity materials show the greatest changes due to their lower filler content.^{15,16} It is emphasized that to obtain accurate impressions, it is necessary to follow manufacturers' instructions strictly. Light-body material should be mixed first and then putty in the single-step technique. It is evident that putty has short working times and rapidly increases viscosity after mixing. This necessitates the delay of mixing the putty until seating the tray in the patient's mouth.¹⁷ An author suggested that the accuracy of addition silicon relied upon the material itself rather than the technique.¹⁶ They reported that one stage putty/wash technique and two-stage impression techniques did not significantly change dimensional accuracy. On the contrary, impression materials have improved, so accuracy may be controlled more with the technique than the material itself.^{15,18,19}

CONCLUSION

Compared to the one-step impression technique, the higher linear dimensional accuracy of the two-step impression technique uses polyvinyl siloxane impression material.

LIMITATIONS

In this study, for the two-step impression technique, the cellophane sheet was used as a relief for light-body material, having a thickness of 25–40 microns. However, in their study, Nissan et al. 13 stated that a minimum spacer thickness of 1–2 mm for a two-step technique provides more accurate dies than the spacer thickness of a few microns. Light body thickness greater than 2 mm created larger distortions.

CONFLICT OF INTEREST: None

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