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# An Evaluation of Dimensional Accuracy of Three Polyvinyl Siloxane Putty Wash Impression Techniques – An In Vitro Study.

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## Abstract

**Aim:** To evaluate the dimensional accuracy of stone models obtained by using three different putty wash impression techniques for an elastomeric impression material.

**Material and method:** A total of 45 impressions were made by three routinely used putty wash impression techniques by using an addition silicone elastomeric impression material. Further, three groups of stone models were made consisting 15 models each using one step, two step with polythene spacer and two step with 2mm relief in a custom-made metal mould. The dimensional accuracy of the retrieved stone models were measured by using digital travelling microscope at inter-abutment and intra-abutment distance. One-way ANOVA was used to compare the differences among the three putty-wash impression techniques.

**Results:** Significant differences were found among the three impression techniques for all heights and inter-abutment dimensions (P<.001).

**Conclusion:** Within the limitations of this study, it was concluded that two step putty wash impression technique with 2mm relief should be the impression of choice.

**Keywords:** Putty wash impression, inter-abutment, intra-abutment, accuracy, elastomeric impressions.

**Introduction**

Impression of the teeth and their surrounding structures is of utmost importance, as it is neither possible nor desirable to make wax patterns for fixed prosthesis directly in the mouth. So, for accurate replication of tooth preparations and to record their precise arch position we need impression material with minimal distortion.[1] Moreover, well fitting indirect restorations can only be made if there are accurate models of the oral tissues made available from the impressions having high degree of dimensional accuracies and detailed reproducibility.[2] Therefore, a Prosthodontic rehabilitation is majorly dependent upon the type of impression material and impression procedure utilized.[3]

Over the years various impression materials have been advocated for making the impressions for fabrication of fixed partial dental prosthesis.[1] Good dimensional stability of impression materials has been the traditional goal of researchers and clinicians.[4] Elastomers were developed as an alternative to natural rubber during World War II. These materials have since been modified chemically and physically for use in dentistry.[2] The American Dental Association (ADA) Specification No. 19 identifies these materials as "non-aqueous elastomeric dental impression materials".[3] Four basic types of elastomeric impression materials are currently in use: Polysulphide, Condensation silicones, Addition silicones and Polyether.[5]

Polysulphides are good in surface detail reproduction but they are dimensionally unstable when stored for longer period of time with an objectionable odour and long setting time.[3] Condensation silicone was introduced in 1960. As, with the polysulphides, the setting reaction produce a volatile by-product (ethyl alcohol) leading to shrinkage of the impression material. Therefore, condensation silicones have dimensional accuracy slightly greater than polysulphides after six hours. Polyvinyl siloxane have overcome the disadvantage of polymerization shrinkage over the condensation silicone as there is no by product release.[5] Polyether is hydrophilic and rigid material with high modulus of elasticity but because of its low tear strength, bad odour, poor colour stability, short working-setting time and if immersed in disinfectant can change the dimensional stability and high stiffness after setting has limited its use.[6]

Nowadays, Polyvinyl siloxane are widely used in fixed prosthodontics due to their excellent elastic recovery, dimensional accuracy, ability to produce multiple casts from single impression, good detail reproducibility, ease of handling and moderately short working and setting time. Moreover, it possesses good mechanical and flow properties along with excellent wetting characteristics when applied to the prepared tooth.[3] To obtain a dimensionally accurate result and at the same time incorporate stability to the material, various techniques of making polyvinyl siloxane impression have been advocated -one step putty wash impression technique, two step putty wash impression technique, single mix custom tray technique, copper band technique, closed bite double arch technique, matrix impression technique.[7] These methods involve either using a custom tray with a uniform thin relief spacer for the impression material or making the impression first with high filler containing (Putty) and later relining it with low filler containing (light body) impression material.[8]

According to a study conducted by **Mitchell J and Feger P**, the putty consistency gives inaccurate impressions.[9] Hence, it is important to reline the putty impression with light body impression material after completion of polymerization reaction of putty impression. But, the difference in cross-sectional thickness of material in a stock tray is about 2 mm thicker than that in a custom tray.[2] This mandates precision in fabrication of the custom tray because small differences in cross-sectional thickness (bulk of impression material) can affect the dimensional accuracy. So, dimensional accuracy is not only affected by the technique but also by the different spacer designs.[10]

Thus the need for this study; so as to evaluate the dimensional accuracy of Polyvinyl siloxane by comparing one step and two step putty wash impression techniques as well as effect of bulk of the material which is controlled by spacer design by using different impression techniques.

**Materials And Method**

This in-vitro study was conducted in the Department of Prosthodontics including Crown and Bridge, MM College of Dental Sciences and Research, in collaboration with the Department of Mechanical Engineering; MM college of Engineering, Mullana, Ambala .

The study aimed to evaluate the accuracy of stone models retrieved by using 3 impression techniques with elastomeric impression materials that are commonly used in clinical practice which are:

a) One step putty wash impression technique.
b) 2 step putty wash impression technique with polythene spacer.
c) 2 step putty wash impression technique with 2mm relief.

**Specimen Fabrication**

Specimens were fabricated using a custom made metal mould which was designed according to ANSI / ADA specification No. 108:2009. The custom mould has two shouldered full crown preparations/abutments fabricated in frustum shaped cone. The base diameter of abutment (QR, ST) was 15 mm, height from shoulder margin (IJ, KL) was 12 mm, shoulder width (QM, NR, SO, PT) was 2 mm and taper (MA, NB, OE and PF) was $7^0$, vertical dimension of two abutments (IJ, KL) was 12 mm and horizontal distance between center of two abutments (IK) was 24mm [Figure 1A]. Abutments were fabricated with two occlusal grooves i.e. AB, CD and EF, GH that intersect at a point I and K respectively which helps in taking measurements [Figure 1B].

Two custom made cylindrical stainless steel covers of 2 mm thickness were also made to fit individual frustum of cones which acted as a spacer during impression taking with perforated metal cover acting as tray. A custom made metal cover (impression tray) was fabricated to fit over the master die with a uniform space of 14mm between the frustum of cones and their inner wall of the metal cover to accommodate or house the impression material. The die was highly polished so that the samples could be easily removed once the impression material was set [Figure 2].

According to manufacturer recommendation, a thin layer of tray adhesive (3M ESPE VPS tray adhesive) was painted 7 minutes prior to impression making over the inner surface of the custom metal tray and allowed to dry [Figure 3]. Equal amount of base and catalyst of putty (Aquasil soft putty, Aquasil Ultra LV (Regular Set) / Dentsply) was hand mixed till the colour was uniform, and was dispensed in the perforated metal mold cover for impression making [Figure 4A & B]. Light body was injected for wash impression differently for three techniques. The impressions were made using three different impression techniques.

**Grouping of Specimens**

A total of 45 impressions (n=45) were made i.e. 15 impressions with each impression technique and divided accordingly:

**Group I -** Impressions were made by using **One step** putty wash impression technique. Putty and light body were mixed simultaneously. The material was dispensed on the abutment by the help of mixing gun according to manufacturer's instructions [Figure 5]. Impression tray was locked in the mold and gentle finger pressure was applied. The impression was allowed to set at room temperature.[11]

**Group II-** Impressions were made by using **Two step** putty wash impression technique using Polythene sheet as a spacer. Polythene sheet was placed on the abutments so that uniform space was created for light body impression material [Figure 6]. Putty impression was made and allowed to set first. Polythene sheet was removed and light body was dispensed on the abutment by the help of mixing gun using manufacturer's instructions. Impressions were repositioned and allowed to set at room temperature after the impression tray was locked in the mold with gentle finger pressure.

**Group III-** Impressions were made by using **2 step putty wash impression technique with 2mm relief.** Stainless steel prefabricated cylindrical copings (2mm thick) were placed on both the abutments so that we had a uniform space for light body impression material. Putty impression was made and allowed to set first. Thereafter, the stainless steel copings were removed and light body impression material was dispensed on the abutment by the help of mixing gun [Figure 7A & B]. Impressions were repositioned and allowed to set. Impression tray was locked in the mold and gentle finger pressure was applied.

Impressions of all the groups were stored at room temperature for at least one hour and then were poured. Die stone / Type IV gypsum products (Kalabhai Ultrarock Die Stone) was vacuum mixed and vibrator was used to pour the impressions.[12] To standardize the effect of setting expansion of the die stone, the powder was accurately weighed and the water was dispensed by using a graduated cylinder according to manufacturers recommended water powder ratio (23ml / 100gms).The stone was allowed to set for one hour at room temperature. After a required setting period, the samples were removed from the impression mold [Figure 8].

**Measurement of Samples**

All die stone models of dies were measured using a travelling microscope with a metric micrometer vernier scale with a resolution up to 0.01mm [10] [Figure 9]. Each group was then measured for:

**Dimension I** - the vertical height of 1st abutment from shoulder margin mark as IJ (interabutment distance of 1st abutment)

**Dimension II** – the vertical height of 2nd abutment from shoulder margin mark as KL (interabutment distance of 2nd abutment)

**Dimension III** - the horizontal distance between reference mark I and K (interabutment distance between two abutments.

All the measurements were repeated three times and then the mean for each dimension was calculated and compared.

The percentage of deviation from die model (master metal model / mmm) to stone model (master stone model / msm) for each dimension by different impression techniques was calculated by the mean distance between the master stone model (msm) and the master model (mmm) divided by the mean of the master metal model multiplied by 100.

$$\text{Percentage of deviation} = \frac{(msm-mmm)}{mmm \times 100}$$

**Statistical Analysis**

Statistical analysis was carried out using SPSS (statistical package for social sciences), version 17.5. Mean and standard deviation of each stone model group was measured and tabulated. An intergroup comparison was done using a one-way ANOVA followed by post hoc Tukey's test (Multiple Comparisons Bonferroni) and the p value ≤0.001 was considered significant in all tests.

**Results**

**Descriptive Analysis (**Mean, Standard Deviation and Standard Error) calculated the mean value of all dimension variance (IJ- Dimension I, KL- Dimension II and IK- Dimension III) of each group which shows a slight variation from master model die. While among all the three groups; Group I shows maximum deviation and Group III shows least deviation [Graph 1]. **Oneway Analysis Of Variance (ANOVA)** calculated the mean square value of all dimension variance (IJ- Dimension I, KL- Dimension II and IK- Dimension III) which shows a huge variation if compared between the groups and shows least difference if compared within the groups [Graph 2].

**Oneway Descriptive Analysis** shows Dimension I (IJ) and Dimension III (IK) of Group I, Dimension II (KL) of Group II shows highest degree of mean difference from the base line (0) [Graph 3]. **Post Hoc Tests (Multiple Comparisons Bonferroni)** calculated dimension variance of Group I compared with Group II and Group III which showed highest dimensional variation. If dimension variance of Group II and Group III are compared it showed least dimensional variation [Graph 4].

**Discussion**

The success of any prosthodontics treatment depends on the dimensional accuracy of the impression material (any substance or combination of substances), impression technique and the retrieved stone model.[1] The dimensional stability/accuracy is a property which is expressed as the ability of the material to retain its original size and form. It is one of the important variables which contribute to be accurate, therefore help in the fabrication of a successful prosthesis.[4]

The dimensional changes occurring within an elastomeric impression material depends largely on accuracy of impression material, elastic recovery, dimensional stability, hydrophilicity, viscosity of material and degree of change during polymerization.[2] The impression material needs to flow into the undercut areas and set in that position, and should be able to rebound back to its original position after removal from the mouth. This property of impression material is known as elastic recovery. Polyvinyl siloxane impression material has best (99%) elastic recovery. Polyvinyl siloxane impression materials are extremely popular in fixed prosthodontics because of their combination of excellent physical properties, handling characteristics, and dimensional stability.[13] Moreover, polyvinyl siloxane impression material is hydrophobic and is used to produce very high contact angles. Later formulation included non-ionic surfactant in the materials which improved the wettability and lowered the contact angle. This made it easier to pour the models without incorporating voids.[14]

To obtain maximum accuracy, manipulation of impression material also plays an important role that includes bulk of impression material, viscosity of impression material, adequate mixing, adhesion of impression material to the tray and pouring of the impression.[10] Our study focused the effect of three putty-wash impression techniques -one step putty wash impression technique, two step putty wash impression technique with polythene spacer, two step putty wash impression technique with 2mm relief on the

dimensional accuracy of an elastomeric impression material ie Polyvinyl Siloxane.

Numerous studies have compared the accuracy of various impression techniques for addition silicone impression material by reporting the undesirable dimensional changes and inaccuracies of the stone casts due to excessive and uneven thickness of the elastomeric impression material. Though multiple researches on polyvinyl siloxane impression material have focused on their properties; only little information is available regarding the effect of techniques and tray selection on dimensional accuracy. Thus, the need for this study was to evaluate the dimensional accuracy of Polyvinyl siloxane by comparing one step and two step putty wash impression techniques as well as effect of bulk of the material which is controlled by spacer design by using different impression techniques.

In the present study, dimensional accuracy of models can be determined by using a custom made metal mould which was designed according to ANSI / ADA specification No. 108:2009. A custom master mould was fabricated with two shouldered full crown preparations / abutments, fabricated in frustum shaped cone to retain the size and form by measuring the intra-abutment and inter-abutment distance. A custom made metal cover which functions as an impression tray was fabricated to fit over the master die with a uniform space of 14mm between the frustum of cones and their inner wall of the metal cover to accommodate or house uniform bulk of the impression material.[8] Then, an appropriate tray adhesive was applied according to manufacturer's instructions for proper adhesion of impression material. Tray adhesive also helped to counteract the polymerization shrinkage of impression material by redirecting this shrinkage towards impression tray wall, thus minimized the marginal opening of a casting.[14]

The result of the present in vitro study showed that Group III ie Two step putty wash impression technique with 2mm relief showed no significant difference between the means of three dependent variable from the master mould. This technique resulted in the fabrication of more precise models. The result is favoured by the studies done by **Nissan J et al [10], Dugal R et al [8], Fakhrzadeh et al [15], Jamshidy L et al [16]** which concluded that the two step putty wash impression technique was more accurate than one step technique. **Chugh A et al [17]** also documented that putty wash impression technique with controlled bulk of wash impression is accurate which is absent in one step and two step putty wash impression technique with polythene spacer.

Whereas, the results of this invitro study is advocated by the studies done by **Hung et al [18] & Idris et a1.[19]** Their study compared the accuracy of two PVS impression techniques, one-step and two-step which concluded that accuracy of impression is not technique-dependent rather than the lack of control in the wash bulk.

Overall, it was seen that the accuracy of addition silicone impression material irrespective of the impression technique used were within the accepted range of <1.5% (according to ISO 4823 specification) for almost all the measurements. The uneven size variation can be attributed to the use of polythene sheet which acted as spacer in Group II where the thickness of the wash material cannot be controlled leading to differential contraction of impression material.

The limitation of this in-vitro study is that dimensional changes in present were recorded indirectly by performing measurements on stone casts. The minimum dimensional differences with master model were expected because of high strength stone which expands on setting. The rate of expansion of die stone (Kalabhai Ultrarock Die stone) is 0.10% as per manufacturer. Although the influence of

setting expansion of stone casts can be ignored with methods used in it and is approximately the same for all, as stated by **Vitti RP et al.**[20]

Though, it is recommended that further studies may be taken up to study other properties like wetability, tear strength, permanent deformation, working and setting conditions.

**Figures and Graphs**

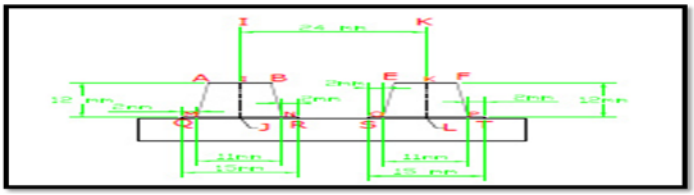


Figure 1A: Measurements on the custom made abutments

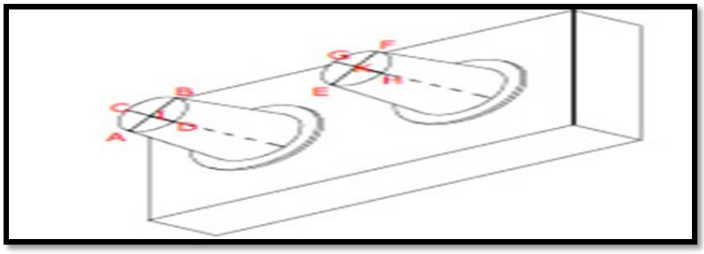


Figure 1B: Cross-grooves on their occlusal surfaces taken as reference point

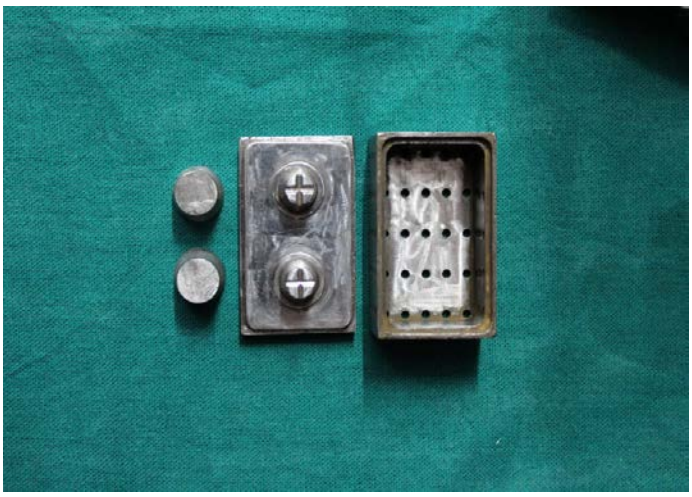


Figure 2: Polished Custom made metal die with a perforating impression tray and two stainless steel covers

Figure 3: Application of tray adhesive


Figure 4A: Polyvinyl siloxane putty


Figure 4B: Polyvinyl siloxane Light body (Aquasil Ultra LV (Regular Set) / Dentsply)

Figure 5: Putty and light body mixed simultaneously for one step impression making

Figure 6: Polyethylene sheet used as a spacer for creating space for wash impression material

Figure 7A: Putty impression made with Prefabricated copings in place

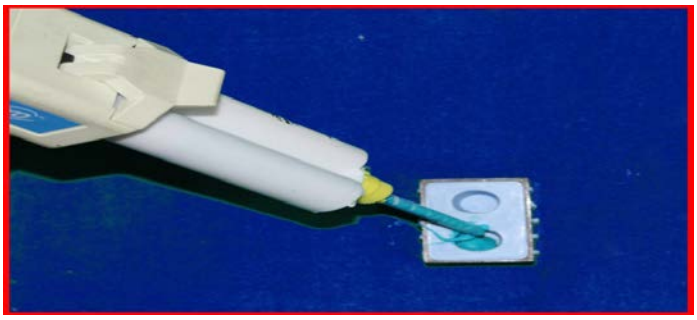


Figure 7B: Light body injection in the wash space created by prefabricated Stainless steel copings

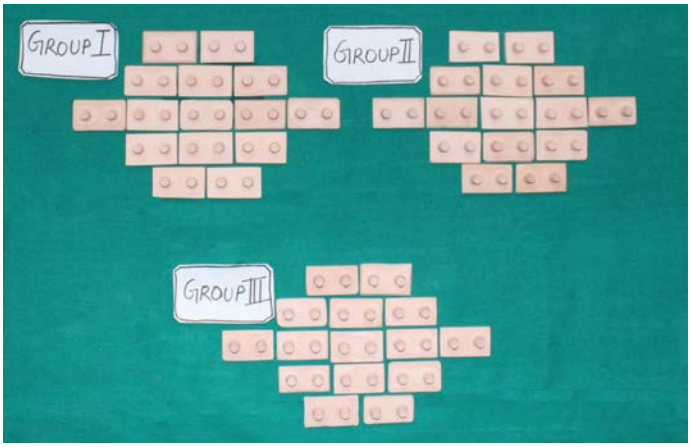
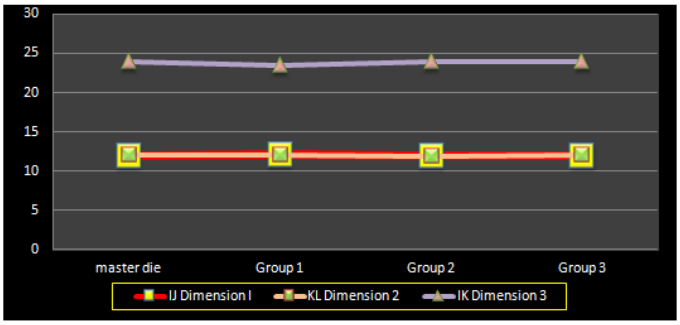
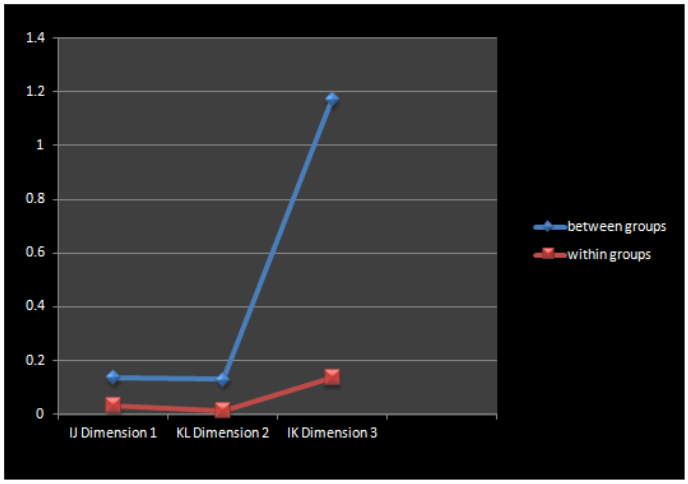



Figure 8: Retrieved stone models and grouping of models

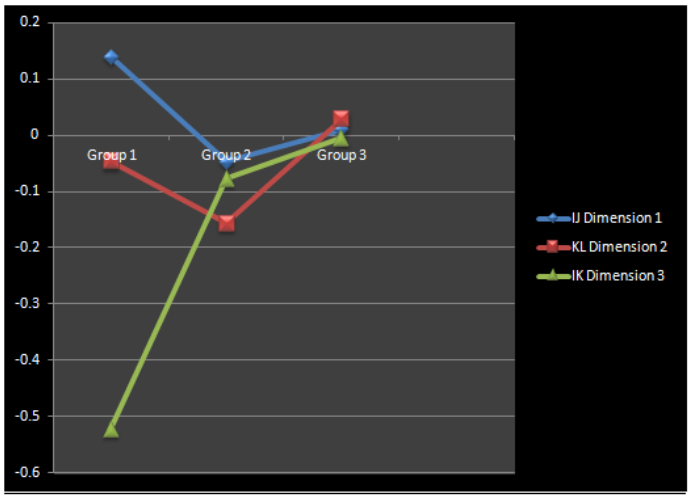
Figure 9: Testing of samples



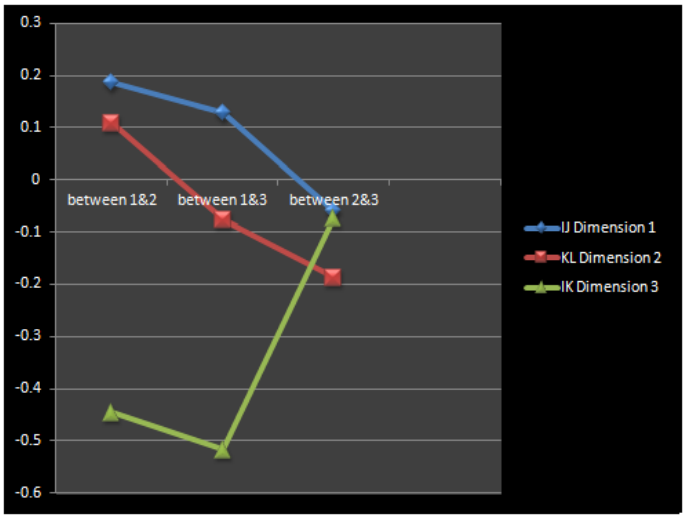

Graph 1: Descriptive Analysis (Mean, Standard Deviation And Standard Error Values)




Graph 2: Oneway Analysis of Variance (ANOVA)




Graph 3: Oneway Descriptive Analysis




Graph 4: Post Hoc Tests (Multiple Comparisons Bonferroni)

## Conclusion

Within the limitations of the of the present in vitro study, it could be concluded that two-step putty wash impression technique with 2mm relief showed least dimensional changes and has maximum linear dimensional accuracy. Hence, this impression technique could be the choice when impression has to be made in fixed prosthodontics.

## References

1. Pandey A, Mehtra A. Comparative study of dimensional stability and accuracy of various elastomeric materials. JDMS 2014;13(3):40-5.
2. Wassell RW, Barker D, Walls AWG. Crowns and other extra-coronal restorations: Impression materials and techniques. British Dental Journal 2002;192:697-90.
3. Levartovsky S, Levy G, Brosh T, Harel N, Ganor Y, Pilo R. Dimensional stability of polyvinyl siloxane impression material reproducing the sulcular area. Denatl Materials Journal 2013;32(1):25-31.
4. Wadhwani CP, Johnson Gh, Lepe X, Raigrodski AJ. Accuracy of newly formulatd fast-setting elastomeric impression materials. J Prosthet Dent 2005 Jun 30;93(6):530-9.
5. Joshi PR, Bhrat GS, Shrenoy V. Comparative evaluation of dimensional accuracy of addition silicone and condensation silicone impression materials- An in vitro study. Malaysian Dental Journal 2009jan1:3(1).
6. Vitti RP, Silva MA, Consani RL, Sinhoreti MA. Dimensional accuracy of stone cast made from silicone based impression materials and three impression techniques. Braz Dent J 2013sept-oct; 24(5):498-502.
7. Karsten M, Andreas D, Ursula R, Gert R, Klrus B, Bernd R. Experimental study on the use of spcer foils in two-step putty and wash impression procedures

using silicone impression materials. J Prosthet Dent 2015Apr30;113(4):316-22.

8. Dugal R, Raikar B, Musani S. Comparative evaluaton of dimensional accuracy of different polyvinyl siloxane impression techniques. An in-vitro study. J Int Health 2013oct:5(5):85-94.
9. itchell J, Feger P, Wostmann B. Dimensional accuracy of 2-stage putty wash impressions: Influence of impression trays and viscosity. Int J Prosthodont. 1970;20(6):573-575.
10. Nissan J, Grass M, Shifman A, Assif D. Effect of wash bulk on the accuracy of polyvinyl siloxane putty wash impression. J Oral Rehabil.2002Apr:24(4):357-61.
11. Caputi S, Varvara G. Dimensional accuracy of the resultant cast made by monophase, one-step and two-step and a novel two-step putty / light body impression technique. An in-vitro study. J Prosthet Dent 2008;Apr99(4):274-81.
12. Morford HT, Tames RR, Zardiackas LD. Effect of vaccum and pressure on accuracy, reproducibility and surface finish of stone cast made from polyvinyl siloxane. J Prosthet dent1986 Apr 1;55:466-70.
13. Harcourt K J. A review of modern impression material. Aus J Dent. 1978;23(2):178-86.
14. John R. Agar Dent Clin N Am 2004; 48: 2.
15. akhrzadeh V, Eslami H, Nasrollah AP, Negahdari R, Falsafi P, Sabeti M. The comparison of dimensional accuracy of modified two-stage putty-wash condensation s polyvinyl molding method and distance two-stage putty-wash molding method. IJCDR. 2016 Oct 1;9(4):265-71.
16. Jamshidy L, Mozaffari HR, Faraji P, Sharifi R. Accuracy of the One-Stage and Two-Stage Impression Techniques: A Comparative Analysis. Intl J Dent. 2016 ;Nov 24:16-20.
17. Chugh A, Arora A, Singh VP. Accuracy of different putty-wash impression techniques with various spacer thickness. Int J Clin Pediatr Dent 2012;5:33–38.
18. Hung SH, Purk JH, Tira DE, Eick JD. Accuracy of one-step versus two-step putty wash addition silicone impression technique. J Prosthet Dent 1992;67:583-9.
19. Idris B, Houston F, Claffey N. Comparison of the dimensional accuracy of one- and two-step techniques with the use of putty/wash addition silicone impression materials. J Prosthet Dent 1995;74;535-41.
20. Vitti RP, Silva MA, Consani RL, Sinhoreti MA. Dimensional accuracy of stone cast made from silicone based impression materials and three impression techniques. Braz Dent J 2013;24:498-502.