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Comparison Of Dimensional Accuracy Of One Step And Two Step Impression Techniques Using Three Different Addition Silicone Impression Materials - An In Vitro Study

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ABSTRACT: Background: The study was conducted to compare the accuracy of one step putty wash impression technique with two step impression technique with three different addition silicone impression materials (Affinis , Flexceed and photosil). The measurements of the precision stainless steel die and gypsum product dies, prepared from two different techniques with three different impression materials were evaluated by standard microscope measurements at three different location.

Materials & methods: A stainless steel precision die (Figure 8) with a brass base was fabricated which mimicked a three unit preparation. A perforated metal tray (Figure 9) was fabricated for making the impression of the precision die. A total of 90 specimens were prepared which were divided into six groups of fifteen specimens each: Group A1: One step impression technique with Affinis,Group A2: Two step impression technique with Affinis.,Group B1: One step impression technique with Flexceed., Group B2: Two step impression technique with Flexceed, Group C1: One step impression technique with Photosil, Group C2: Two step impression technique with Photosil. The readings obtained were tabulated and subjected to statistical analysis using one – way ANOVA and Tukey's post hoc tests.

Results: One way ANOVA demonstrated highly significant values among the study groups (p<0.001) both when comparing inter abutment distances (AB, BC, AC) as well as for differences as compared to the stainless steel precision die .Post hoc test for multiple comparisons between the mean differences of all groups. Highly statistically significant differences were seen between the means differences for all the study groups.

Conclusion: The present study was a step towards comparing the three different addition silicone impression materials with one step and two step impression technique for their dimensional accuracy.

Key words: Dimensional, Two step, One step

1. INTRODUCTION

Making an impression is an integral part of prosthodontic treatment. A variety of dental impression materials currently exist, the majority of which have originated in non-dental related fields.**(Wadhwani et al 2005).** There are four different elastomeric impression materials which include polysulfide, polyether, condensation silicones and addition silicones, and each one of them has specific chemical reactions and setting characteristics.. The addition silicones which were introduced in 1970's, have high accuracy, little dimensional change after setting, moderately short working and setting time and excellent recovery from deformation on removal are commonly used these days. The addition silicones have overcome the disadvantage of polymerization shrinkage of the condensation silicone **(Joshi, Bhrat and Shrenoy 2009).**

Accurate impressions are influenced by a variety of factors that include the impression material, impression material manipulation and impression technique, impression tray material, impression tray design, tray deformation potential, impression retention to the impression tray surface, impression thickness, impression removal, thermal changes after removal, storage condition after removal and material used for making the dies and its compatibility with the impression material **(Hoyos and Soderholm 2011).**

Most commonly employed techniques for making the impressions are one-step technique and two-step technique. With the one-step technique, a low or medium consistency wash material is syringed on and around the prepared tooth, and then freshly mixed very high or putty consistency material, loaded in a stock tray, is seated over the wash material. This procedure is commonly referred to as double-mix technique, simultaneous or squash technique **(Shiozawa et al 2013).** In two step putty/ light body technique, impressions are made by using a spacer (often a vacuum-processed tray) that is placed over the teeth before an impression is taken in a putty material. After the putty has set, the spacer is removed and a low viscous material is placed around the teeth, as well as in the spacer region of the putty impression, where upon a final impression is made **(Hoyos & Soderholm 2011).** Various studies have suggested that the space provided for the wash material using the two-step putty-wash technique with uniform 1 mm and 2 mm thick spaces left for the wash material resulted in highly accurate impressions and stone dies **(Tjan et al 1992, Rajapur et al 2012 and Shiozawa et al 2013)**.

There is much discussion in the dental literature regarding the effect of the impression technique on the accurate fit of the cast restorations. There are many authors who claim that one step impression technique is better than two step technique. **(Bader & Setz 1991, Noack et al 2004, Luthardt et al 2008, Pande & Parkhedkar 2013)** while others claim that two step impression technique has better dimensional accuracy than one step impression technique **(Nissan et al 2000, Dhiman et al 2001, Caputi & Varvara 2008 and Chugh & Arora 2012).**

Therefore this study was carried out to compare the accuracy of one step putty wash impression technique with two step impression technique with three different addition silicone impression materials (Affinis , Flexceed and photosil). The measurements of the precision stainless steel die and gypsum product dies, prepared from two different techniques with three different impression materials were evaluated by standard microscope measurements at three different location.

2. MATERIALS AND METHOD:

A stainless steel precision die (Figure 8) with a brass base was fabricated which mimicked a three unit preparation. A perforated metal tray (Figure 9) was fabricated for making the impression of the precision die. A total of 90 specimens were prepared which were divided into six groups of fifteen specimens each: Group A1: One step impression technique with Affinis,Group A2: Two step impression technique with Affinis.,Group B1: One step impression technique with Flexceed., Group B2: Two step impression technique with Flexceed, Group C1: One step impression technique with Photosil, Group C2: Two step impression technique with Photosil.

In one step putty wash impression technique, putty base and catalyst were mixed according to manufacturer recommendations and loaded onto the perforated tray. For Group A1 & Group B1, the light body impression material was simultaneously injected over the abutments and on the surface of the putty at the intended position of the abutments using an automatic dispensing gun (Figure 7, No.9). The perforated tray loaded with putty and light body was placed on the abutments ensuring complete seating of tray over the die. The tray was left in place undisturbed for a period of time according to manufacturer instructions. Once the impression was set, it was removed and examined. For Group C1, light body was manually mixed using agate spatula (Figure 7, No.8) on glass slab (Figure 7, No.7) and material was loaded & injected with the help of a syringe (Figure 7, No.12). A total of fifteen impressions were made for each material (Figure 11, 13 and 15).

In two step putty wash impression technique The preliminary putty impression of the master die was made using a 2 mm thick vaccum form sheet (Figure 10) as a spacer for the light body material on the abutment teeth and the material was allowed to set according to manufacturer recommendations. For Group A2 & Group B2, the vaccum form sheet was removed following setting of the putty material to provide uniform space for the light body impression material. Light body impression material was injected into the space created by the spacer by automatic dispensing gun (Figure 7, No.9) and the tray was again placed over the master die accurately. The light body was also allowed to set undisturbed for a period of time according to manufacturer instructions. Once the impression was set, it was removed and examined for any defects. For Group C2, light body was manually mixed using agate spatula (Figure 7, No.8) on glass slab (Figure 7, No.7) and material was loaded & injected with the help of a syringe (Figure 7, No.12). A total of fifteen impressions were made for each impression material (Figure 11, 13 and 15). All impressions were stored at room temperature for one hour before pouring in Die stone Type IV (ULTRAROCK, Kalabhai Karsan Pvt Ltd, India) (Figure 7, No 1). The material was mixed as per manufacturer recommended water powder ratio with the help of vaccum mixing machine. Impression was then poured under vibrator and allowed to set for one hour before separation of master cast from the impression (Figure 12, 14 and 16).The measurement of specimens was done using a Traveller's Microscope (Figure 17). The three readings for taken for each specimen & their mean were calculated. The corresponding distances (AB, BC and AC) were also measured on the stainless steel precision die (Figure 8) and compared with those from specimens of all the impression materials with both techniques to determine their dimensional stability and accuracy. The readings obtained were tabulated and subjected to statistical analysis using one – way ANOVA and Tukey's post hoc tests.

3. RESULTS

Three distances (AB, BC and AC) from the centre of the three abutments of the stainless steel precision die were measured using a Traveller's microscope. For each specimen, three readings were measured and the mean was calculated. The difference in the mean measurements for all groups was compared to the stainless steel precision die. The data from the tables was subjected to statistical analysis **Appendix B** by one - way ANOVA (Analysis of Variance) (Table VII) and Tukey's post hoc test for multiple comparisons. A perusal of Tables IV, V and VI shows that the greatest difference in the distance AB, BC and AC as compared to the stainless steel precision die was observed for Group C1 (0.05793 mm, 0.05620 mm and 0.11413 mm). The mean difference in the distance AB, BC and AC as compared to the stainless steel precision die was least in Group B2 (0.01900 mm, 0 .01987 mm and 0.03887 mm respectively) (Graph IV, V and VI respectively).

One way ANOVA demonstrated highly significant values among the study groups ($p<0.001$) both when comparing inter abutment distances (AB, BC, AC) as well as for differences as compared to the stainless steel precision die .Post hoc test for multiple comparisons between the mean differences of all groups. Highly statistically significant differences were seen between the means differences for all the study groups.

Table I: Descriptive statistics for the difference in the distance AB in all groups as compared to the standard die measurements (mm).

Group	n	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A1	15	.03700	. 003117	.000805	.03527	.03873	.032	.042
B1	15	.02860	.002667	.000689	.02712	.03008	.024	.034
A2	15	.03307	.002939	.000759	.03144	.03469	.028	.038
B2	15	.01900	.002673	.000690	.01752	.02048	.015	.024
C1	15	.05793	.004350	.001123	.05552	.06034	.051	.065
C2	15	.03280	.003649	.000942	.03078	.03482	.027	.038

Table II: Descriptive statistics for the difference in the distance BC in all groups as compared to the standard die measurements (mm)

Group	n	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A1	15	.03607	. 002434	.000628	.03472	.03741	.032	.041
B1	15	.02893	.002631	.000689	.02748	.03039	.025	.033
A2	15	.03287	.002973	.000768	.03122	.03451	.028	.037

B2	15	.01987	.001995	.000515	.01876	.02097	.017	.023
C1	15	.05620	.003950	.001020	.05401	.05839	.051	.063
C2	15	.03287	.003021	.000780	.03119	.03454	.028	.038

Table III: Descriptive statistics for the difference in the distance AC in all groups as compared to the standard die measurements (mm)

Group	**n**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
					Lower Bound	**Upper Bound**		
A1	15	.07307	. 002890	.000746	.07147	.06467	.068	.079
B1	15	.05753	.002503	.000646	.05615	.05892	.053	.062
A2	15	.06593	.003494	.000902	.04400	.06787	.060	.074
B2	15	.03887	.003681	.000951	.03683	.04091	.033	.046
C1	15	.11413	.004257	.001099	.11178	.11649	.108	.122
C2	15	.06567	.004320	.001116	.06327	.06806	.057	.074

4. DISCUSSION

Impression making is a critical step in the process of fabricating successful crowns and bridges. Any inaccuracy in the impression making will ultimately have an adverse effect on the fit and adaptation of the final restoration as precise fitting of casting is obtained in five steps beginning from tooth preparation, impression making, wax pattern, investment and finishing of the casting. The impression material is used in the first phase, and any inaccuracy is carried through to the finished casting **(Petrie et al 2003).**

Dimensional stability of impression materials has been discussed in the dental literature, revealing significant differences in the properties of products of the same type. Some dentists still are unclear which category of impression material is best for clinical use to ensure success in prosthodontic procedures. New materials have been developed and subjected to continuous modifications with the aim of improving the impression quality, but these modifications do not guarantee maintenance of their properties. Therefore, it is important to evaluate the dimensional accuracy of recently developed materials **(Vitti,Sobrinho and Sinhoreti 2011).**

Addition silicone impression materials are supplied in a number of viscosities, ranging from very low viscosity to very high viscosity putty materials**(Donovan & Chee 2004).** Monophasic addition silicones do not provide the same level of accuracy as provided by combination of low viscosity/ high viscosity materials as they have more polymerization shrinkage. Therefore in this study putty / light body combination was used to make impression with one step and two step impression techniques for three different addition silicone impression materials.

For the purpose of study, a modified ANSI/ADA specified stainless steel metal die with a brass base was fabricated for making the impressions **(Walker et al 2005 and Caputi & Varvara 2008).** Stainless steel die was used because it does not absorb water, does not expand or shrink under variable temperatures and does not react with the impression materials being used. The dimensions were chosen so as to mimic natural teeth abutments as well as to facilitate easy making of the impressions.

Different materials can be used as a spacer material such as wax, polyethylene sheet, polypropylene sheet, acrylic and vaccum form sheet etc of varying thickness for making impressions with two step putty wash impression technique. A vaccum form sheet of 2 mm thickness was used as spacer in this study as this sheet remains stable and provides uniform space for wash material. Various studies have suggested that the space provided for the wash material using the two-step putty-wash technique with uniform 1 mm and 2 mm thick spaces left for the wash material resulted in highly accurate impressions and stone dies **(Tjan et al 1992, Rajapur et al 2012, Chugh, Arora and Singh 2012, Shiwoza et al 2013 and Kumar et al 2014)**. Therefore, a spacer of 2 mm thickness was used in this study.

The mean distance AB, BC and AC for all the Groups (A1, A2, B1, B2, C1 and C2) was found to be greater than the stainless steel precision die. These findings indicate that there was increase in inter-abutment distance which could be attributed to the polymerization shrinkage of the material towards the adhesive coated perforated tray. This finding was in agreement with the findings of **Tjan et al 1992, Rueda et al 1996 and Brosky et al 2002.**

Tukey's post hoc analysis revealed that the mean difference for distance AB, BC and AC for Group A1, Group B1 and Group C1 were observed to be greater than their respective counter parts viz Group A2, Group B2 and Group C2, the mean difference for AB (0.008400 mm, 0.014067 mm and 0.025133 mm respectively), BC (0.007133 mm, 0.013000 mm and 0.023333 mm respectively) and AC (0.015533mm ,0.027067 mm and 0.048467mm respectively) indicating that one step impression technique showed more differences from the stainless steel precision die for all materials as compared to two step impression technique. All the mean differences were found to be statistically significant. These results indicated that two step impression technique appears to be dimensionally more accurate than one step impression technique for all the three different addition silicone materials tested. Results of this study were consistent with those of **Dhiman et al 2001** who compared the accuracy of reproduction of addition silicone impression material (Reprosil) with putty/ wash one step and two step techniques indicating that two step impression technique produced more accurate casts with less standard deviation.

The results of this study were in agreement with the studies of **Johnson & Craig 1986, Nissan et al 2000, Chee et al 2004, Caputi & Varvara 2008**, **Chugh, Arora & Singh 2012, Nissan et al 2013 and Dugal, Railkar & Musani 2013.** The critical factor that influences the accuracy of two step impression technique is control over the wash bulk which compensates for contraction with minimal dimensional changes **(Nissan et al 2000)** while in one step technique, the putty and wash materials are mixed and loaded simultaneously and are in contact with each other while the polymerization reaction is in progress. The resultant shrinkage is the total polymerization shrinkage of putty and wash materials together which results in greater polymerization shrinkage (**Idris, Houston and Claffey 1995 & Nissan et al 2000).**

For the one step impression technique, Group A1, Group B1 and Group C1 statistically significant differences ($p<0.05$) were found among the groups.The mean difference for distance AB, BC and AC was found to be greatest for Group C1, followed by Group A1 and Group B1 from the stainless steel precision die indicating that specimens obtained from Group B1 (Flexceed) were dimensionally more accurate as compared to Group A1 (Aquasil) and Group C1 (Photosil).

For the two step impression technique, Group A2, Group B2 and Group C2 statistically significant differences ($p<0.05$) were found among the groups.The mean difference for distance AB, BC and AC was found to be greatest for Group C2, followed by Group A2 and Group B2 from the stainless steel precision die indicating that specimens obtained from Group B2 (Flexceed) were dimensionally more accurate as compared to Group A2 (Aquasil) and Group C2 (Photosil).

Thus, the results of study indicated that Flexceed impression material was the most dimensionally accurate addition silicone impression material for impression making with both one step and two step putty/wash impression technique among all materials studied. Normally the addition silicone impression materials did not differ significantly among themselves. The differences found in the dimensional accuracy among these materials could be attributed to the variability in composition of matrix- filler ratio which can provide the material with different level of polymerization shrinkage and elastic recovery **(Vitti ,Sobbrinho and Sinhoreti 2011).** The results of study were in accordance to **Hung et al 1992 and Idris, Houston and Claffey 1995** who reported that impression accuracy was not technique dependent but was influenced by material used for impression making.

There were some limitations of this study. A standardized stainless steel die used for making the impression; although caliberated for precise comparisons, does not resemble the behavior of oral tissues. Other conditions not examined included the effects of gravity, rotational path of impression removal and different arch forms for maxilla and mandible.

5. CONCLUSION

The present study was a step towards comparing the three different addition silicone impression materials with one step and two step impression technique for their dimensional accuracy. Further studies can be done on newly introduced materials like hydrophilic addition silicones, nanophillic addition silicones and vinyl polyether siloxane. Further investigations are also necessary to assess how the material's properties are affected by the presence of saliva or moisture in the oral cavity.

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Figure 1: Affinis impression material
(a) Putty (Base & Catalyst)
(b) Light body

Figure 2: Flexceed impression material
(a) Putty (Base & Catalyst)
(b) Light body

Figure 3: Photosil impression material
(a) Putty (Base & Catalyst)
(b) Light body (Base paste & Catalyst Paste)

Figure 4: Armamentarium 1.Die stone 2.Vaccum form sheet 3.Tray adhesive 4.Rubber Bowl 5. Plaster spatula 6.Time clock 7.Glass slab 8.Agate spatula 9.Dispensing gun 10.Tip for Affinis light body 11.Tip for Flexceed light body 12. Syringe for Photosil light body

Figure 5: Stainless steel Precision die

Figure 6: Impression Tray

Figure 7: Stainless Steel Precision die with spacer (2 mm)

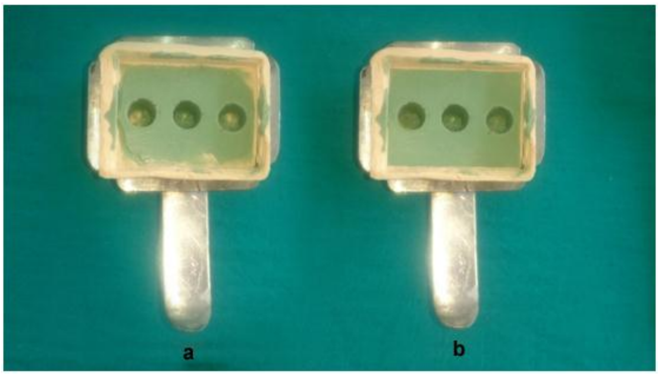

Figure 8: Impressions with Affinis material
(a) One step impression technique
(b) Two step impression technique

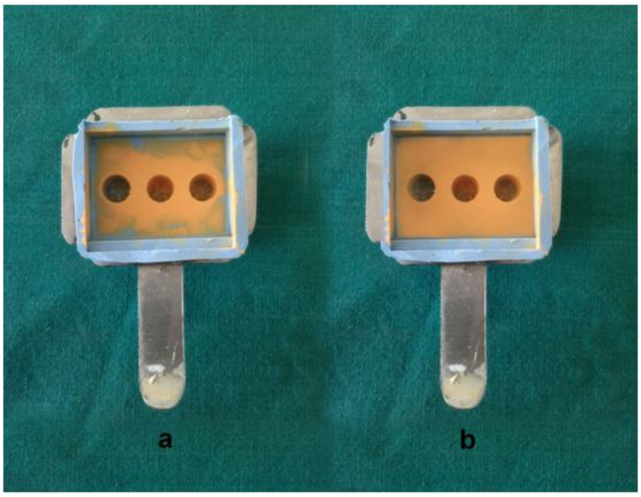

Figure 9: Impressions with Flexceed material
(a) One step impression technique
(b) Two step impression technique

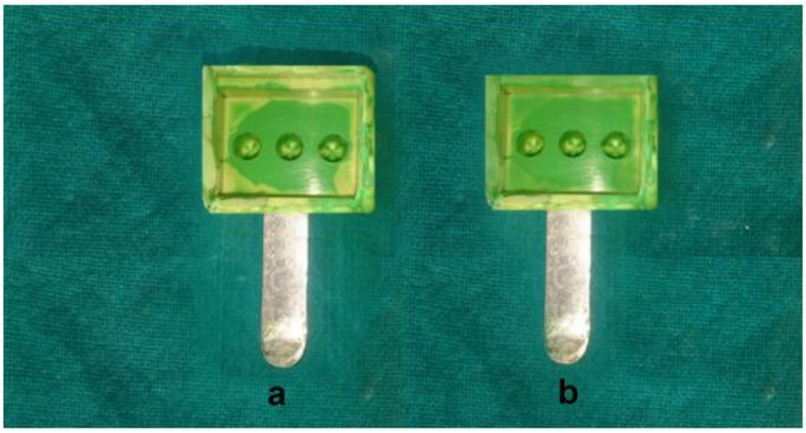

Figure 10: Impressions with Photosil material
(a) One step impression technique
(b) Two step impression technique

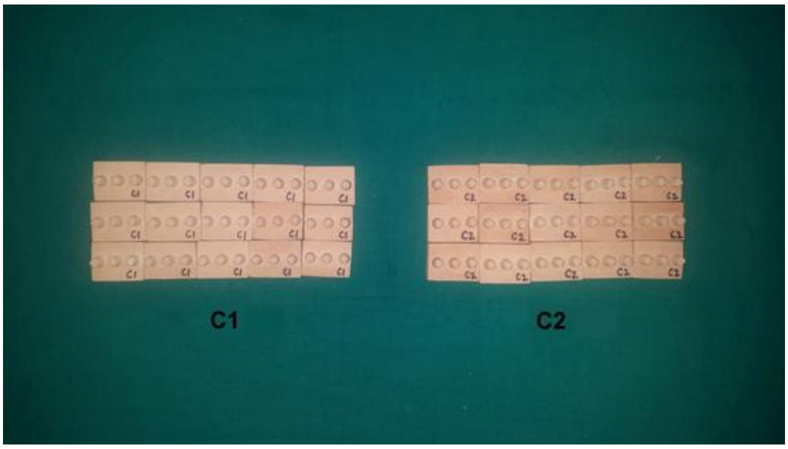

Figure 11: Specimens of Groups C1& C2