Original Research Article

Evaluation and comparison of dimensional accuracy of newly formulated vinyl polysiloxanether impression material with two different conventional elastomeric impression materials using two different impression techniques after disinfection- An in vitro study

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Abstract

Background: The success of some forms of dental treatment depends upon the accuracy with which a restoration can be manufactured in the laboratory, using models constructed from impressions. Clearly, the precision of the initial impression both in terms of dimensional accuracy and detail reproduction is a prerequisite for success. To achieve an accurately fitting casting, precision must be maintained from the impression to the casting procedure. This involves five steps: impression, die, wax pattern, investment, and gold casting. The impression material is used in the first phase, and any inaccuracy is carried through to the finished casting. Many factors are important in choosing a material. Some of the factors involved are accuracy, dimensional stability, working time, shelf life, electroplating capabilities, and taste. **Aims:** The aim of the study is to compare the dimensional accuracy of newly formulated vinyl polysiloxanether impression material with two rubber base impression material using two different techniques after disinfection. **Material And Methods:** Impression was made with acrylic tray using each elastomeric impression material by one-step and two step impression technique. (n=10) total 60 samples. **Result:** Comparison of study variables between the groups was done. This shows that the P value for height, diameter and the inter-abutment distance was more than 0.05, so the value is not significant statistically. **Conclusion:** A laboratory test method was used to measure stone dies made from three rubber base elastomers used in two clinically simulated techniques in two situations. Dies obtained at different impression technique demonstrated the dimensional changes of the elastomers after setting. 1. Generally, more uniform dies were produced from the silicone impression material. 2. One silicone material was significantly different from the other two.

Key Words: AS1 Addition polysilicone single step without disinfection AS2 Addition polysilicone single step with disinfection AD1 Addition polysilicone two-step without disinfection AD2 Addition polysilicone two-step with disinfection

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INTRODUCTION

The clinical success of fixed prosthodontic procedures is dependent, in part, upon the dimensional accuracy of elastomeric impression materials and impression procedures. It is important that the model of the oral cavity is an accurate three dimensional replica, because the prosthesis is made on this model and therefore, it directly affects the fit of the indirect restoration[1]. Clearly, the precision of the initial impression both in terms of dimensional accuracy and detail reproduction is a prerequisite for success. To achieve an accurately fitting casting, precision must be maintained from the impression to the casting procedure. This involves five steps: impression, die, wax pattern, investment, and gold casting. The impression material is used in the first phase, and any inaccuracy is carried through to the finished casting. Many factors are important in choosing a material. Some of the factors involved are accuracy, dimensional stability, working time, shelf life, electroplating capabilities, and taste. There are a great variety of products from which to choose; they possess a wide range of properties. Dentists should have the opportunity to select materials which have the properties with which they are comfortable and yet which do not sacrifice accuracy and stability[2]. Bailey *et al* indicated that many of the steps involved in the process of fabricating cast restorations resulted in dimensional changes, and if some of these changes compensated for each other, it would be advantageous[3]. Their ability to produce accurate casts and dies is subject to the dimensional changes that occur during polymerization of the impression materials. The variable thicknesses of the impression materials in each stock tray may result in dimensional changes and inaccuracies in the cast.,[4,5] It has generally been concluded that a custom tray is advisable for procedures requiring the utmost accuracy. A rigid tray with a relief to 2 to 3 mm is standard. [6] Autopolymerizing acrylic resin is the preferred material for these trays.

MATERIAL AND METHODS

SAMPLE SIZE

Impression was made with acrylic tray using each elastomeric impression material by one-step and two step impression technique. (n=10) total 60 samples.

STUDY METHOD

Fabrication of stainless steel die A stainless steel model containing 2 complete-crown, tapered abutment preparations was made on a lathe according to the ANSI/ADA specifications (8.015 mm in height, 6.330-mm and 8.450-mm base dimensions ,with a 28.270-mm distance between the centres of the abutments) (Fig. 1).The dimensions of this stainless steel model were also recorded. This was then used as the definitive standardized model for the comparison of the impression techniques in this study[7].

Impression making The 3 types of impression materials evaluated in this study were the newly formulated vinyl siloxanether (VSE) (Identium; Kettenbach GmbH, Eschenburg, Germany), vinyl polysiloxane (VPS) (Express,3M Dental Products, St. Paul, Minn.),and polyether (PE) (ImpregumPenta; 3M ESPE, St. Paul, Minn). For each material, the recommended tray adhesive was used: Identium Adhesive (Kettenbach GmbH),Polyether Adhesive (3M ESPE), or Silfix (Dentsply Caulk). All materials were mixed at room temperature (25°C) using automix dispenser (Kettenbach), and placed within the working time recommended by the manufacturer. The impressions were allowed to polymerize approximately three times longer (15 minutes) than the time recommended by the manufacturer to ensure adequate polymerization occurred at room temperature. Single-step technique, in which both materials polymerize simultaneously, reduces chair side time and saves impression material. This technique yields accurate impressions independently of the curing kinetics of the syringed material alone. For the 2-step technique, a preliminary impression was taken with the high-viscosity material and relined with the low-viscosity product . No die spacers or relief of the preliminary impression were carried out, in order to simulate the hydraulic and hydrophobic technique. A total of 60 impressions were made with each material. 10 impressions were made by single step of which 5 impression with each material was disinfected with 3.5% gluteraldehyde and 5 impressions with each material were used as non-disinfected controls. Another 10 impressions was made by two-step of which 5 impression with each material was disinfected with 3.5% gluteraldehyde and 5 impressions with each material were used as non-disinfected controls. Total of 30 impressions were subjected to disinfecting treatments based on ADA recommendation, immersion in 3.5% glutaraldehyde solution for 30 minutes.

RESULTS

Table 1: Comparison of study variables in groups studied

Groups	Height (In µm)	Diameter(In µm)	Inter-abutment Distance(In µm)
IS1	8084±101.4	6534±93.7	28512±133.1
IS2	8072±64.2	6464±75.4	28344±132.2
P	0.829	0.229	0.080+

IS1-Identium by single step impression technique without disinfection. IS2-Identium by single- step impression technique with disinfection Comparison of study variables between the group was done. This shows that the ***P*** value for height, diameter and the inter-abutment distance was more than 0.05, so the value is not significant statistically.

Table 2:

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment Distance(In µm)
ID1	8176±69.9	6244±136.7	28252±330.9
ID2	8056±79.2	6140±72.1	28336±197.7
P	0.135	0.955	0.639

ID1- identium by two- step impression technique without disinfection ID2- identium by two- step impression technique with disinfection Comparison of study variables between in the group was done. This shows that the ***P*** value for height, diameter and the inter-abutment distance was more than 0.05, so the value is not significant statistically.

Table 3:

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment Distance(In µm)
AS1	8196±55.5	6484±129.9	28372±178.1
AS2	8164±49.8	6476±82.9	28440±120.8
P	0.104	0.910	0.500

AS1- polysilicone by single step impression technique without disinfection AS2- polysilicone by single step impression technique with disinfection. Comparison of study variables between in the group was done. This shows that the P value for height, diameter and the inter-abutment distance was more than 0.05, so the value is not significant statistically.

Table 4:

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment distance(In µm)
AD1	8236±124.4	6316±47.7	28404±187.8
AD2	8156±51.8	6264±93.2	28340±259.6
P	0.221	0.299	0.667

AD1- polysilicone by two-step impression technique without disinfection AD2- polysilicone by two-step impression technique with disinfection. Comparison of study variables between in the group was done. This shows that the P value for height, diameter and the inter-abutment distance was more than 0.05, so the value is not significant statistically.

Table 5:

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment Distance(In µm)
MS1	8006±19.5	6352±117.1	28360±164.9
MS2	8064±38.5	6404±80.5	28389.8±229
P	0.017*	0.437	0.819

MS1-polyether by single- step impression technique without disinfection MS2-polyether by single- step impression technique with disinfection Comparison of study variables between in the group was done. This shows that the P value for diameter and the inter-abutment distance was more than 0.05, so the value is not significant statistically .Whereas the comparison between the height value was less then0.05 showing significance.

Table 6:

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment distance(In µm)
MD1	8015±16.3	6268.4±54.8	23363.4±11.4
MD2	8027.4±65.9	6534±93.7	28365.6±16.9
P	0.694	0.065+	0.358

MD1- polyether by two step impression technique without disinfection. MD2- polyether by two step impression technique with disinfection. Comparison of study variables between in the group was done. This shows that the P value for height, diameter and the inter-abutment distance was more than 0.05, so the value is not significant statistically.

Table 7: Overall significance among study variables

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment distance(In µm)
F	6.498	5.843	0.955
P	<0.001**	<0.001**	0.498

Comparison of study variables between all the group was done. The values were subject to ANOVA analysis, between the group (i.e with and without) was compared by student t test. This shows that the P value for the inter-abutment distance was more than 0.05, so the value is not significant statistically .Whereas the comparison between the height and diameter value was less then0.05 showing significance.

Table 8: Comparison of study variables in groups studied for impression technique

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment distance(In µm)
IS(1+2)	8078±80.2	6099±88.2	28428±153.2
ID(1+2)	8116±94.7	6042±103	28294±260.8
P	0.346	0.229	0.178

Comparison of study variables in groups studied for between impression technique, its shows that it is not significant statistically as P value being more that 0.05 for height, diameter, and inter-abutment distance.

Table 9:

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment distance(In µm)
MS(1+2)	8196±85.5	6480±102.8	28406±147.9
MD(1+2)	8036±99.2	6290±75	28372±216.3
P	0.001**	<0.001**	0.686

Comparison of study variables between in the group for impression technique was done. This shows that the P value for the inter-abutment distance was more than 0.05, so the value is not significant statistically .Whereas the comparison between the height and diameter value was less then0.05 showing statistically significant.

Table 10:

Groups	Height(In µm)	Diameter(In µm)	Inter-abutment distance(In µm)
AS(1+2)	8035±42	6378±98.6	28374.9±188.8
AD(1+2)	8021.2±45.7	6327.3±102.8	28364.5±808.2
P	0.491	0.275	0.339

Comparison of study variables in groups studied for between impression technique, its shows that it not significant statistically as P value being more that0.05 for height, diameter, and inter-abutment distance.

Table 11: Overall significance among study variables for impression technique

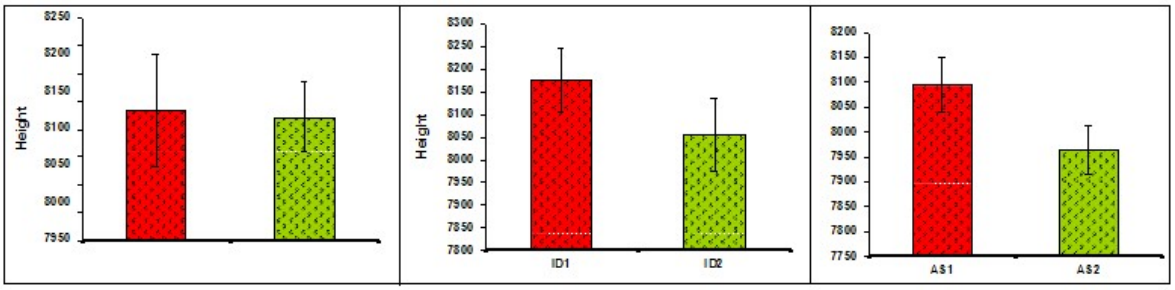
Groups	Height	Diameter	Inter-abutment Distance
F	7.493	11.360	0.964
P	<0.001**	<0.001**	0.448

Comparison of study variables between in all the group for impression technique was done. All the values were subjected to ANOVA analysis. This shows that the P value for the inter-abutment distance was more than 0.05, so the value is not significant statistically .Whereas the comparison between the height and diameter value was less then0.05 showing statistically significant.

Table 12: Comparison of study variables in groups studied for various materials

Groups	Height(In µm)	Diameter(In µm)	Inter- abutment distance(In µm)
Material I	8097±87.6	6520.5±95.9	27119.7±571.1
Material A	8113±124	6385±131	28389±181.2
Material M	8028.1±43.3	6352.7±101.5	28361±219.2
F VALUE	4.898	12.975	0.964
P VALUE	*<0.001***	*<0.001***	0.387

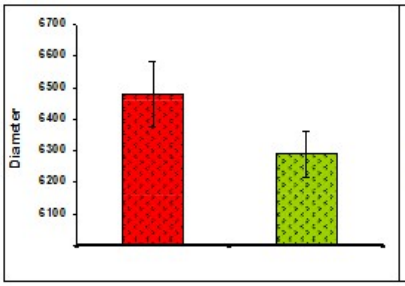
Comparison of study variables between in all the group for impression was done. All the values were subjected to ANOVA analysis. This shows that the P value for the inter- abutment distance was more than 0.05, so the value is not significant statistically. Whereas the comparison between the height and diameter value was less then0.05 showing statistically significant.



Graph 1

Graph 2

Graph 3



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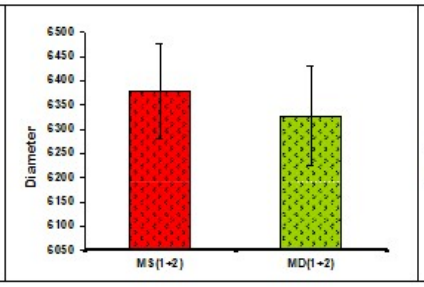

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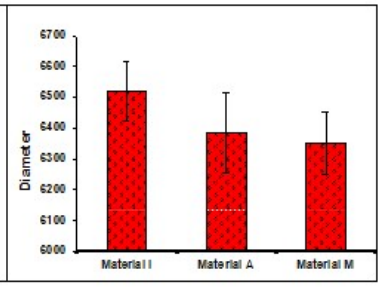

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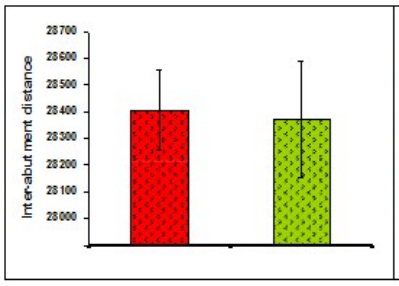
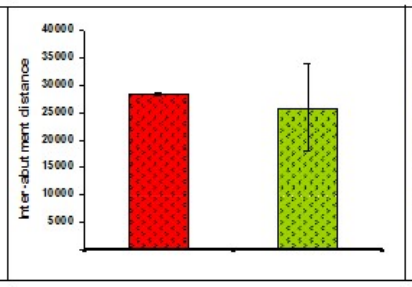
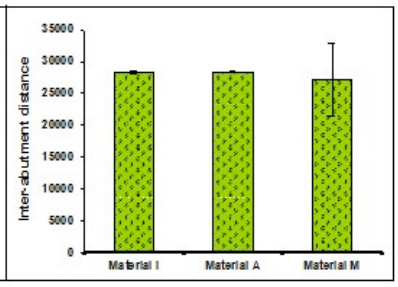


Graph 7



Graph 8



Graph 9

Graph 1: This graph shows comparison of height of cast made by single step impression technique using polysiloxenther; **Graph 2:** This graph shows comparison of height of cast made by double step impression technique using polysiloxenther with glutraldehyde; **Graph 3:** This graph shows comparison of height of cast made by single step impression technique using polysilioxane; **Graph 4:** This graph shows comparison of height of cast made by double step impression technique using polysilioxane; **Graph 5:** This graph shows comparison of diameter of cast made by single and double step impression technique using polyether; **Graph 6:** This graph shows comparison of diameter of cast made by all the impression material; **Graph 7:** This graph shows comparison of inter-abutment distance of cast made by single and double step impression technique using polysilixone; **Graph 8:** This graph shows comparison of inter-abutment distance of cast made by single and double step impression technique using polyether; **Graph 9:** This graph shows comparison of inter-abutment distance of cast made by single and double step impression technique using all 3 impression material

Figure 1

DISCUSSION

The impression techniques used in fixed prosthodontic is an essential stage in fabrication of crowns. The aims of this study were to evaluate and compare the dimensional accuracy of newly formulated vinyl polysiloxanether impression material with two different conventional elastomeric impression materials using two different impression techniques after disinfection. It is appreciated that in this study had some limitations in that there were several variables which were not considered independently, for example the effect of the tray material, adhesives and the thickness of the light and heavy body impression materials. The measurements were carried out using a High Precision stereo zoom Microscope and the manufacturer claims that this instrument has a resolution of 1 μm (0.001mm) and has estimated the repeatability of recording well-defined points as being 2 μm (0.002 mm) in the horizontal direction and 15 μm (0.015 mm) in the vertical direction. It was therefore possible to record changes in dimensions for the impression materials in fine detail. Within the limitations of the study the results showed that, in general all materials demonstrated a high degree of dimensional accuracy and stability. There were however some changes recorded in the dimensional accuracy and stability depending on which disinfectant was used. These changes, although small, may be of clinical significance in fixed prosthodontics.8 Elastomeric impression materials are classified as Type I, II, or III according to certain of their elastic properties and dimensional change aftersetting. A Type II classification requires that a material not change more than 1.0% after 24 hours. A Type I or III material must not exceed 0.5% negative linear change[11]. The differences among materials were highly significant. One silicone material was significantly better than the other two, i.e., the stone dies showed the least variation from the master dies. The two remaining silicones were not significantly different from each other. These differences were true for diameters as well as for heights9. The primary null hypothesis was that there would be no differences in accuracy of working casts and dies, among the 3 impression systems, in comparison to the master, for the techniques used. This hypothesis was rejected since there were statistically significant differences among the 3 systems. The secondary null hypothesis was that impression systems would not be affected by immersion disinfection. This hypothesis was rejected for the cast dimensions (H,D,IAD)but was accepted for the dimensions of the working die. 10 According to information provided by the manufacturer, the platinum-initiated vinyl siloxanether consists of a copolymer of α,ω-divinylpolydimethylsiloxane and α,ω-divinyl polyether crosslinked by an organohydrogenpolysiloxane . The composition is intended to incorporate the natural hydrophilicity of conventional polyether materials along with the desirable properties of vinyl polysiloxane materials, such as elastic recovery and tear resistance. To further improve the wetting characteristics and flowability, a surface tension eraser (STES) and wetting conditioner surfactant (WCS) have been incorporated into the vinyl siloxanether, per the manufacturer. The results of the present study are comparable to the results of similar past studies of polyether and vinyl polysiloxane impressions, in which the dimensions were shown to be larger compared to the master model, and the dimensional changes of the working dies are also comparable. Given the newly formulated vinyl siloxanether impression material, with claims of its low contact angles in the unset (representing the hydrophilicity to the prepared tooth and gingival tissues) and set conditions (representing the hydrophilicity to fluid gypsum), it is important to discuss how accuracy might be affected when the impressions are made by two different techniques. Custom trays produced dies that were more accurate overall when compared with those produced by stock trays .The thermoplastic custom tray produced dies as accurate as those ofthe custom acrylic resin tray[11]. An attempt was made to simulate the clinical condition as closely as possible. Impressions of the prepared stainless steel model were made using the putty-wash technique with, polyether, polyvinyl siloxane, polysiloxenther impression material. Impression material was mixed using automix dispenser for heavy body and auto mix handgun for the light body viscosity material.Impressions were made using Custom trays fabricated with auto polymerizing resin with two sheet base plate wax for standardizing the spacer thickness for the impression material. Impression were made by single step and two step technique of each impression material. The impressions were allowed to polymerize approximately three times longer (15 minutes) than the time recommended by the manufacturer to ensure adequate polymerization occurred at room temperature.[12] All impressions were stored at room temperature (20°C) for 1 hour before pouring in improved type IV stone (Pearlstone), mixed according to the manufacturer's instructions, with a water/powder ratio of 10 ml/100. The impression was separated from the stone cast 1 hour after pouring and readings were taken 24 hours later[12]. The image of stone die was made using Stereo zoom microscope, Model-MZS0745T+SD2, Magnification upto 45X . The image was viewed on the computer screen and measurements are made using 'Weld check' software. The measurement were made for height, diameter and inter-abutment distance was taken, the reading was subjected to student test, ANOVA analysis. The results of the present study are comparable to the results of similar

past studies of polyether and vinyl polysiloxane impressions in which the dimensions H and D were shown to be larger compared to the master model, and the dimensional changes of the working dies are also comparable. Given the newly formulated vinyl siloxanether impression material, with claims of its low contact angles in the unset (representing the hydrophilicity to the prepared tooth and gingival tissues) and set conditions (representing the hydrophilicity to fluid gypsum), it is important to discuss how accuracy might be affected when the impressions were made by different impression techniques. The differences between the master model and the working casts for the height and diameter were small: a 0.019-mm to 0.025-mm difference was found overall, compared to the master model. These values are within the range of normal tooth mobility. For example, in a clinical study, single posterior teeth have been shown to move an average of 0.084 mm with wedging .Thus, working casts with any of the impression systems investigated appear to provide enough accuracy between abutments for long-span fixed partial dentures.

CONCLUSION

A laboratory test method was used to measure stone dies made from three rubber elastomers used in two clinically simulated techniques in two situations. Dies obtained at different impression technique demonstrated the dimensional changes of the elastomers after setting.

1. 1.Generally, more uniform dies were produced from the silicone impression material.
2. One silicone material was significantly different from the other two.
3. One technique (single step) caused the stone dies to be undersized in diameter, but had less effect upon die length.
4. Two techniques (two step) were not significantly different from each other.

Considering the limitations of this in vitro study, it was shown that vinyl siloxanether dual- viscosity impressions display acceptable accuracy for clinical use with both the impression techniques, since the results for vinyl siloxanether were comparable to the results for representative polyether and vinyl polysiloxane materials. Although some statistically significant differences were observed among the 3 impression systems, the clinical impact of these differences is minor, considering the overall accuracy of casts was high. The effect of impression technique of the impressions had no negative effects.

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