COMPARATIVE EVALUATION OF SURFACE DETAIL REPRODUCTION AND DIMENSIONAL STABILITY OF POLY ETHER, POLYVINYL SILOXANE AND VINYL POLYSILOXANE ETHER IMPRESSION MATERIALS - AN IN VITRO STUDY

Dissertation Submitted to

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment for the Degree of

MASTER OF DENTAL SURGERY

BRANCH I

PROSTHODONTICS AND CROWN & BRIDGE

APRIL 2018

CERTIFICATE

This is to certify that this dissertation entitled **"COMPARATIVE EVALUATION OF SURFACE DETAIL REPRODUCTION AND DIMENSIONAL STABILITY OF POLY ETHER, POLYVINYL SILOXANE AND VINYL POLYSILOXANE ETHER IMPRESSION MATERIALS - AN IN VITRO STUDY"** *is a bonafide research work done by* **DR.SHYMA ROSE.P.D.,** *under our guidance during her postgraduate study period between* ***2015 – 2018.***

This Dissertation is submitted to **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY**, *in partial fulfillment for the degree of* **MASTER OF DENTAL SURGERY in PROSTHODONTICS AND CROWN & BRIDGE - BRANCH I.**

It has not been submitted partially or fully for the award of any other degree or diploma.

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ENDORSEMENT BY PRINCIPAL /

HEAD OF THE INSTITUTION

This is to certify that this dissertation entitled **"COMPARATIVE EVALUATION OF SURFACE DETAIL REPRODUCTION AND DIMENSIONAL STABILITY OF POLY ETHER, POLYVINYL SILOXANE AND VINYL POLYSILOXANE ETHER IMPRESSION MATERIALS - AN IN VITRO STUDY"** *is a bonafide research work done by* **DR.SHYMA ROSE.P.D.** *under the guidance of* **Dr.A.Shyam Mohan, MDS, DNB** Professor and HOD, *Department of Prosthodontics and Crown & Bridge, Rajas Dental College and Hospital, Kavalkinaru, Tirunelveli-627105.*

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ACKNOWLEDGEMENT

First of all I reveal my deep sense of gratitude to the **Lord Almighty Jesus Christ** for his grace and helping me to overcome all the odds and for being the unfailing source of support, comfort and strength throughout my life in achieving unexpected goals and proceed towards a new height of destination.

I consider it as a great privilege and honour to express my inestimable gratitude to my respected guide **Dr.A.Shyam Mohan, MDS, DNB.,** Professor and Head of the Department of Prosthodontics and crown & bridge for his inspiring guidance, constant encouragement, unlimited help, sound advice and care throughout the course of this study as well as during my entire P.G Curriculum.

It is my extreme pleasure to extend my gratitude to my beloved chairman **Dr. Jacob Raja, MDS** for his valuable support and constant encouragement throughout the period of my study.

It gives me immense pleasure to convey my deep indebtedness to our respected principal **Dr.Cynthia Sathiasekar, MDS** for her guidance throughout the course.

I also express my deep sense of gratitude and my sincere thanks to **Dr.Indhumathi MDS,** Reader**; Dr.Sabarinathan MDS,** Reader; **Dr.Aarthi Rajambigai MDS,** Reader; **Dr. Ramesh Raja MDS,** Reader; **Dr. S.I.Joephin Soundar MDS,** Senior lecturer; **Dr Sajna Oommen MDS,** Senior lecturer; **Dr.Swathi MDS,** Senior lecturer; for their timely assistance and help throughout the study.

I am thankful to my colleague **Dr. Selvinraj.S** for his patient endurance, co-operation and support he offered me during my post-graduate course.

I thank my senior colleagues **Dr. Arul Joshy, Dr H Mani Bernard** and my junior colleagues **Dr.Shakthi Prakash Dr.Rinu Prathap, Dr.Celin Joel, Dr.S.Krishnasuthan, Dr Gnanavel** for their kind help and constant support. My sincere thanks to all those who have helped me directly and indirectly.

My sincere appreciation to **Dr.Porchelvan** for helping me in statistical analysis and my heart filled thanks to all the teaching and non teaching staffs in the **Department of Physics, Annamalai University** for assisting me.

My heartfelt gratitude to my husband **Dr.S.Bennet** for his constant support to achieve my dreams and aspiration. I am extremely thankful to my lovable son **Benin Bennet Samuel** and my daughter **Benishaya Bennet Rose** for their sacrifices throughout my studies.

I am thankful to my beloved parents **Mr.C.Pathrose** and **Mrs.D.DevaNesam** for helping me to achieve my goals.

I wish to express my heartfelt thanks to my **Shine India family** for their constant encouragement, support, help and prayers throughout my course of the study.

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ABSTRACT

TITLE: Comparative Evaluation of Surface Detail Reproduction and Dimensional Stability of Poly Ether, Polyvinyl Siloxane and Vinyl Polysiloxane Ether Impression Materials - An in vitro Study.

Background

An accurate duplication of the patients hard and soft tissue is an significant. one to give a precise fitting cast restoration. Impression making an integral part of prosthetic dentistry. Development of material science has allowed integrating qualities of hydrophillic poly ether and hydrophobic polyvinyl siloxane into a newer hybrid material vinyl polysiloxane ether. The aim of this In vitro experiment is to compare the newer material vinyl polysiloxane ether with the poly ether and polyvinyl siloxane in terms of accuracy and dimensional stability.

Materials and Methods

Stainless steel dies with ADA specification 19 was made. Die has 3 horizontal and 2 vertical lines are used for taking impression. The horizontal lines are labeled one, two, and three. The horizontal line has a width of the 0.60 mm. Two cross-points at the junction of the vertical lines with line 2 were patent as *x and x' serve. These lines were the beginning* and end points of dimensions for dimensional accuracy. Accuracy was evaluated 30 minutes after making each impression stored in room Stainless steel dies with ADA specification 19 was made. Die has 3 horizontal and 2 vertical lines are used for taking impression. The horizontal lines are labeled one, two, and three. The horizontal line has a width of the 0.60 mm. Two cross-points at the junction of the vertical lines with line 2 were patent as *x and x' serve. These lines were the beginning* and end points of dimensions for dimensional accuracy. Accuracy was evaluated 30 minutes after making each impression stored in room temperature. Continuity of line of replication is measured. If at least 2 of the 3 horizontal lines were reproduced continuously between cross points, this impression was considered satisfactory. The specimens are poured with type IV gypsum product and allowed to set completely for 24 hours. Then dimensional stability was measured in the model by measuring the distance between the two lines and comparing the distance with the measurement of line on metal die which was used to make the impression.

Results

The mean value obtained for the vinyl polysiloxane ether light was 0.0 5370 and for medium was 0.05330. the mean value for light and medium bodied polyvinyl siloxane was 0.06370 and 0.07150 and the mean value for poly ether monophase was 0.06430 respectively. A 2-way ANOVA statistical analysis gave a significance of $p=0.005$ while the post- hoc test for inter group analysis gave a p value of > 0.05.

Conclusion

The newer vinyl polysiloxane ether material showed good surface detail reproduction and Dimensional Stability among all five materials. Although these differences when compared to the master die were significant, such a small discrepancy between the five groups, in relation to the overall dimension can be considered clinically insignificant, such a small discrepancy between the five groups, in relation to the overall dimension can be considered clinically insignificant.

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Introduction

Impression making to duplicate oral condition and tooth morphology is an integral part of prosthetic dentistry. For better accuracy of an impression, both the material and the techniques are important. One important skill for every prosthetic dentist is the facility to construct a finishing impression perfectly and rapidly. Failure to create an ideal impression can effect in poorly fitting prosthesis, increased chair time and expensive remakes; however, this skill is not easily obtained and can often lead to frustration for the dentist, staff, and even the patient. It is up to the dentist to select the best impression material to produce the desired result, while taking into deliberation the clinical objectives of the case. There has been an advancement of impression materials from the reversible hydrocolloid near the beginning of the nineteenth century to the poly ether materials launched in the 1960s, and most newly the polyvinyl siloxane in the 1970s. The hydrocolloid was known for its precision, but the armamentarium required was often unwieldy and took up space in the operatory. Poly ether impression materials were well liked because of its innate hydrophilicity, "snap-set" act, elongated working time, and good flow characteristics.[1,2] polyvinyl siloxane impression materials were chosen because of its easy removal from the mouth, ability to recover after the deformation that occurs during removal, and their lack of taste and odor commonly experienced with poly ether resources.[3]

Progression in elastomeric chemistries has given origin to a new invention of impression materials: a combination of a polyvinyl siloxane and a poly ether impression material, called vinyl polysiloxane ether.[4] It merges some of the most desired properties together into solitary material. Identium was fashioned by Kettenbach (GmbH & Co. KG) and merge these two chemistries to formulate an impression material that was predominantly hydrophilic and have outstanding flowability. During World War II Elastomers were developed to replace natural rubber. To use this materials in dentistry it has been modified chemically and physically[2]. Elastomeric impression materials are currently used in Polysulphide, Poly ether, Condensation silicones and polyvinyl siloxane.

Even though Polysulphides are reproduce good surface detail, when stored for longer period of time they are dimensionally unstable. Poly ether is a hydrophilic and rigid material with high modulus of elasticity but because of its high stiffness after setting, short working and setting time and high cost, limits their use[3]. Condensation silicones releases by-product but the polyvinyl siloxane has overcome the disadvantage of polymerization shrinkage[5]. Polyvinyl siloxane are widely used because of their excellent elastic recovery, good surface detail reproducibility, case of handling, dimensional accuracy, moderately short working and setting time and it has the ability to produce multiple casts from single impression[45]. Development of material science has allowed integrating the hydrophillic qualities of poly ether and polyvinyl siloxane into a newer material vinyl polysiloxane ether. when applied to the prepared tooth in unset condition and in set condition, it should possesses excellent wetting characteristics and good mechanical and flow properties[2]. The factors which influence the quality of impression are viscosity of material, impression material and impression technique. Studies on the new vinylsiloxane poly ether material are far and few between as they are new to the market.

Current study was to evaluate and compare the surface detail reproduction and dimensional accuracy of three elastomeric impression materials that is poly ether, polyvinyl siloxane and vinyl polysiloxane ether by comparing the dimensional accuracy of working casts formed from master model.

The null hypothesis was that no differences would exist in the surface detail reproduction and dimensional stability of these three elastomeric impression materials irrespective of the technique and viscosity.

Aim and Objectives of The Study

The aim of this In vitro experiment is to compare the newer material vinyl polysiloxane ether with the poly ether and polyvinyl siloxane in terms of accuracy and dimensional stability.

The objectives of the present study included the following:

- Evaluate the surface detail reproduction of poly ether (medium), Polyvinyl siloxane (light, medium) and vinyl polysiloxane ether (light, medium).
- Evaluate the dimensional stability of poly ether (medium), polyvinyl siloxane (light, medium) and vinyl polysiloxane ether (light, medium).
- To compare and evaluate the surface detail reproduction of poly ether, polyvinyl siloxane and vinyl polysiloxane ether.
- To compare and evaluate the dimensional stability of poly ether, polyvinyl siloxane and vinyl polysiloxane ether.

Review Of Literature

According to **Markus B et al** [6], the use of metal tray are one of best in regarding the dimensional accuracy and reliability of impression making. Impression taking with disposable plastic stock trays (DiTs) is becoming increasingly popular for daily impression procedure. Rising awareness of the need to prevent cross contamination and save time when cleaning and sterilizing are possible reasons. The use of DiTs, however, may affect the dimensional accuracy of impressions due to elastic rebound during impression taking, especially when putty viscosities are used.

Carrotte et al [7], **stated** that the impressions made with flexible plastic trays produced considerable discrepancies due to flexibility of the tray under heavy impressions. Custom trays provide uniformity of materials which minimize the dimensional changes that might distort an impression.

Gilmore et al [8] explained that when compared with stock trays the use of customs tray produced dies were much more accurate.

Glen Johnson et al [9] stated when compared with stock tray, the dimensional accuracy of the impressions in the custom tray was found to be more accurate in the vertical dimension. When polyvinyl siloxane impressions were used the dimensional accuracy was same with putty/wash, single mix and double mix techniques when they used perforated custom made trays, the most replicative impression and resultant die were found with full adhesive application.

Bomberg et al [10] stated that to minimize marginal opening the use of full application of adhesive and the use of perforated trays were one of the important factor. The use of stock or custom trays and the use of the putty/wash or single-mix technique had no significant effects on the observed marginal opening.

De Araujo et al [11] assessed the effect of bulk of the material and undercuts on the dimensional accuracy of impression materials. He found out that a greater distortion were caused with increase in thickness of the impression material from 1 to 4 mm. As the thickness of the material increased, dimensional accuracy decreased and so the material should be uniform all over the surface.

According to **Craig et al** [12] suggested that the use of automixing tips was important because of its simplicity, convenient to use, cost effectiveness, n spatulation and consistent mix.

Cee et al [13] stated that the uses automixing system reduced the number of bubbles incorporated in the mix for all the impression materials, 3MESPE automix machine with tips were supplied by the manufacturer. Impression technique can be monophase and dual phase. The monophase technique was a single step in a single-step procedure, using materials with a medium viscosity to allow the material itself to record the finer details while avoiding the slumping of the material in the tray, it is economical, less time consuming and simple to perform.

Tjan et al [14] stated that when custom trays were used with full adhesive application the most replicative impression and resultant die were found in a single mix technique. When compared the original stainless steel die the single step technique resulted in slightly larger dies, while the 2-step technique produced significantly smaller dies, without relief. Either poly ether or polyvinyl siloxane with the single-step technique no significant differences were observed in dies.

Hassan AK et al [15] carried out a study to measure changes in silicone impression materials which can affect fitness of prosthesis. Single mix gave more accurate casts than double mix technique. Techniques that use dual-phase materials such as the putty/heavy and light-body wash method may be accomplished in 1 or 2 steps (single mix single step and double mix single step impression techniques). Less chair time is required for the 1- step heavy/light-body technique . as less material was used the cost of material was also reduced. In the 2-step heavy/ light-body technique, the details are recorded by the light-body material while putty /heavy body comprises of the bulk of the impression. Both the techniques were found to be most accurate and it was not significantly different from each other.

Clancy et al [16] evaluated the long-range dimensional stability of three elastomers (one poly ether and two silicones), which were measured directly with testing apparatus in accordance with American Dental Association (ADA) specification 19. In his study, the poly ether (Polygel, Dentsply/Caulk) exhibited the least dimensional changes after four hours at a distance of 25 mm, with an average of 13 ± 6 µm.

Corso et al [17] investigated the influence of temperature changes on the dimensional stability of high- and low-viscosity polyvinyl siloxane (both Express, 3M) and a poly ether (Impregum) with the aid of a plastic impression tray designed specifically for the study. In that study too, a direct measurement of the impression was taken according to American Dental Association specification 19. The mean values of dimensional change lay in the range of 1 to 18 micrometer for both materials.

Chandur et al [18] stated that the working casts and working dies from regular and fast-setting poly ether demonstrated an increase in all dimensions when compared to the master model and stainless steel complete crown preparation. The working casts from the fast-set polyvinyl siloxane were larger than the master model, whereas working dies showed a reduction in mesiodistal dimension and height compared to the stainless steel complete crown preparation. The new fast-setting poly ether and polyvinyl siloxane materials demonstrated dimensional accuracy equivalent to a traditional poly ether.

Panichuttra et al [19] confirmed that hydrophilic polyvinyl siloxane have revealed similar dimensional accuracy to traditional polyvinyl siloxane, when permitted to polymerize in a dried out environment. When American Dental Association specification 19 protocols were used to evaluate the dimensional accuracy, the confirmation from this examination indicated that the dimensional stability of the two hydrophilic polyvinyl siloxane impression materials was not negatively exaggerated by the existence of moisture. According to American Dental Association specification 19 criteria, elastomeric impression materials should not exhibit more than 0.5% dimensional change following 24 hours of polymerization of the material.

Shilling burg et al [20] acknowledged that polyvinyl siloxane impression materials were very accurate when used clinically. The dimensional stability of the material was usually time reliant; Dentists have been reported to wait pouring of impressions up to 72hours; therefore, it was essential that an impression material should wait dimensionally accurate for this period of time. Polyvinyl siloxane impression materials have established better dimensional stability when evaluated with other elastomeric materials, principally because they do not liberate any consequences.

McMurry et al [21] acknowledged that a major drawback of polyvinyl siloxane impression materials was their hydrophobicity. This hydrophobicity can be explained by the material's chemical composition, which contains aliphatic hydrocarbon groups adjoining the siloxane bond. When compared, poly ether and polysulfide impression materials were more hydrophilic than polyvinyl siloxane because of their chemical arrangements containing existing functional groups that create a center of attention and interconnect with water molecules in the course of hydrogen bonding. The hydrophilic compositions there in poly ether were characterized by carbonyl and ether groups, whereas polysulfide included hydrophilic disulfide and mercaptan groups.

According to **Pratten et al** [22] there were two dissimilar features of the hydrophobic character of polyvinyl siloxane materials. The first part relay to the surface free energy of the solid, polymerized polyvinyl siloxane, and the high wettability that characteristically structures when polymerized polyvinyl siloxane impressions were wetted in the midst of dental gypsum materials. The subsequent portion relate to the surface free energy of the not polymerized, liquid stage material, and the capacity or lack of aptitude of the liquid polyvinyl siloxane to wet oral tissues while making impression.

According to **ADA specification No 19** [23], Stainless steel dies scored with 3 horizontal and 2 vertical lines, were used for making an impression. The horizontal lines were marked as one, two, and three and the width of the horizontal lines were 0.016 mm. 2 cross-points at the junction of the perpendicular lines with line two were marked as x and x' which was the starting and the finishing points of the dimensions for dimensional accuracy.

To reproduce oral environment in which the impression material would polymerize in an wet environment, the dies with the applied impression material were transferred into a water bath maintained at 32°C ± 2°C. The medium-bodied type I polyvinyl siloxane impressions material (Reprosil) were removed from the water bath nine minutes subsequent to the impression materials were first applied onto the die, whereas the heavy-bodied type I impression material (Aquasil) were removed following eight minutes. The impressions were allowed to rest for three minutes longer than manufacturer's suggested minimal exclusion time as indicated in American Dental Association 19 requirement for laboratory testing.

Wassell et al [24] stated that the metal dies are the marked surfaces for accurate evaluations; they do not give the behavior of the oral tissues. Metal dies do not attract liquids. In addition, the fundamental surface-free energy of the metal die will be greatly superior to the proteinaceous shells of the prepared teeth and oral soft tissues. In addition, this surface energy will affect the wettability of the impression materials.

Petrie et al [25] stated that the dimensional stability for both hydrophilic polyvinyl siloxane impression materials was not considerably affected by the dry, moist, or wet atmosphere. There was a statistically considerable dissimilarity in the dimensional stability between the two impression materials. Though, the dimensional changes for the two materials were well lower than the ADA standards of maximal shrinkage value of 0.5%. Both the materials were tested adequately with respect to the detail surface reproduction under dry and moist environment, but not under wet environment.

Boksman et al [26] stated that The indications of an accurate, high-quality impression are based on the uniform homogenous mix of materials and are the light and heavy body fully chemically integrated PVS-specific tray adhesive used, applied thoroughly and allowed to set for at least 15 minutes. The tray that was used should be rigid and sturdy. There should be no voids in the impression and no pulls on the margins. Tears or rough surfaces should not be evident. There should be a uniform bond between the impression material, tray adhesive and the tray.

Johnson et al [27] compare the dimensional stability of impression made from (poly ether/polyvinyl siloxane), using two different technique and under two different conditions. After polymerization, impression surface was made wet with 3ml of triple distilled water and for dry condition surface was cleansed with isopropyl alcohol. For better surface data results specimen from surface analyzer subjected to SEM measurement were taken and statistically analyzed. Poly ether showed the best surface detail reproduction under moist conditions. The monophase procedure whether poly ether or polyvinyl siloxane, usually formed enhanced surface detail reproduction under wet or dry environment evaluated to the dual-viscosity procedure.

Chandus et al [28] compared the dimensional accuracy of impression made with fast setting elastomeric impression material and regular setting poly ether by using dual viscosities 1 step impression technique and working casts poured with type IV gypsum and dimensions were measured by using binocular measuring microscope, measurement were statistically analyzed .The result showed the antero-posterior that the fast setting than regular setting poly ether and fast setting polyvinyl siloxane showed more dimensional stability dimension.

Walker et al [29] compared the accurate surface detail re production and dimensional stability of two elastomeric impression materials after disinfection.

Standardize stainless steel die was made, impression were made with poly vinyl siloxane and poly ether and surface details were recorded using scanning electron microscope, dimensional stability measured with measuring microscope. The result was dimensional stability decreased over a period of 1 week and 2 week but polyether impression which was disinfected showed lower shrinkage than those which were not disinfected and all polyvinyl siloxane material.

Jagger et al [30] compared the dimensional stability and accuracy after disinfection greater degree of shrinkage was seen in disinfected impression material and those which were not exposed to disinfection showed smaller percentage of changes.

Caputi et al [31]compared the accuracy of four different impression technique using four different viscosities of elastomeric impression material. He concluded that the accuracy of 1step and 2 step technique performed better than monophase but worse than 2 step injection technique.

Amina et al [32] studied the effect of disinfection on dimensional accuracy of resulting cast with different impression material i.e alginate, zinc oxide eugenol, additional polysiloxane and condensation polysiloxane. Computerized digital caliper was used to measure dimensional stability. Alginate and zinc oxide eugenol paste produced less accurate working cast by polyvinyl siloxane showed better dimensional stability of surface detail reproduction.

Hoyos et al [33] compared the accuracy of polyvinyl siloxane impression material using different tray materials and techniques. Impression that was made with plastic tray showed greater discrepancy irrespective of technique used and impression made with stock trays showed discrepancy with one step than with two steps with or without spacer.

MATERIALS AND METHODS

The present invitro study was conducted to evaluate and compare the newer material polyvinyl siloxane ether with the poly ether and addition silicones in terms of accuracy and dimensional stability.

The following materials ,instruments and equipments were used for the study :

MATERIALS USED

Table 1:

Materials	**Composition**	**Viscosity**	**Manufacturer**
Aquasil	Polyvinyl siloxane	Monophase &light body	3MESPE Germany
Identium	Vinyl polysiloxane ether	Medium & light body	Identium Germany
Impregum	Poly ether	Monophase	3MESPE Germany

INSTRUMENTS USED

1. Penta mix
2. Auto mixing gun
3. Rubber bowl
4. Spatula
5. Stainless steel die
6. Glass slab
7. Spatula

EQUIPMENTS USED:

1. DSLR Camera (Nikon D5200 24.1 MP Digital)
2. Travelling microscope
3. Water bath

METHODOLOGY:

In this research a total of five different viscosities of elastomeric impression materials were used viz. Poly ether (medium body; Monophase), polyvinyl siloxane (monophase & light body), vinyl polysiloxane ether (medium body and light body) (table 1). The impressions were stored under the manufacturer's recommended conditions.

The elastomeric impression materials are divided into 5 groups. (fig.1)

Experimental Groups:

Group 1: Vinyl polysiloxane ether - Light

Group 2: Vinyl polysiloxane ether - medium

Group 3: polyvinyl siloxane – Light

Group 4: polyvinyl siloxane – medium

Group 5: Poly ether – Monophase

Stainless steel block:

An identical ultimate model with stainless steel base was made-up with base equipped on lathe with 38mm diameter and 5mm height. It has 3 parts a block part, mold and riser as shown in figure 5. Each specimen was made using a stainless steel mold. All impression materials were mixed according to the manufacturer's directions by using, where required, clean dispensing automix gun (fig 4). No attempts were made to dispense by weight. Each specimen was made from a separate mix. The catalyst and base components from the manufacturer were supplied in a self mixing apparatus consisting of two cylinders of impression mater, a static mixing nozzle and a ratchet extrusion device. This material was mixed in the manner specified by the manufacturer.

A disc shaped specimen of 32mm diameter and 3mm thickness were prepared using a custom made stainless steel mold. Die had 3 parallel and 2 perpendicular lines which were used for impression making. There were three parallel lines labeled 1, 2, and 3 and the width of the parallel line is 0.60 mm. Two cross- points at the intersection of the perpendicular lines with line 2 were marked *x and x' and served as the beginning* and end points of measurements for dimensional accuracy (fig 6).

The mold was placed on a clean glass plate and was slightly overfilled with the material. Riser was placed on top of the mold and hand pressed to obtain a flat surface specimen. Then the specimen was mounted on the level table of a micromanipulator.

A total of fifty impressions were prepared with 10 impressions in all group. The tray adhesive supplied by the manufacturer was evenly applied over the inner surface of the tray.

The impression making steps of different study groups were as follows:

Study Group I: Tray adhesive suggested by the company was applied to the impression shell of the stainless steel custom made block and allowed to dry for 5 minutes before loading the tray. Light body material was mixed using automix mixing unit (vinyl polysiloxane ether, Identium) and the material was loaded into the stainless steel block. The cartridge was bled in compliance with manufacturer's recommendations to ensure proper dispensing ratios. For impressions made under dry conditions, the material was loaded into a fine-tipped impression syringe and applied to the lined areas of the dies. The impression material was pushed ahead of the syringe tip. This technique yielded the fewest voids as shown in the pilot study. Custom-made plastic molds were placed on the beveled edges of each die, to contain the material and ensure a consistent thickness of 3 mm. A polyethylene sheet and a rigid, flat, metal plate were placed on top of the molds to contain the material as described in ADA specification 19. To simulate oral conditions in which the impression material would polymerize in an aqueous environment, the dies with the applied impression material were transferred into a water bath maintained at 32°C +_ 2°C (fig 7). The impression material was then allowed to set twice the manufacturer's recommended setting time as indicated in ADA specification number 19 for laboratory testing to compensate for the difference in room (21º C + 2º C) and mouth (37º C) conditions (fig 8).

Study Group II: Application of tray adhesive was done before loading the vinyl polysiloxane ether medium body impression material. The one step single mix technique was performed by mixing material using rubber base mixing gun and loaded into the block. Standardized impression making technique was performed as described for group I (fig 8).

Study Group III: Application of tray adhesive was done before loading the polyvinyl siloxane light body impression material. The one step single mix technique was performed by mixing material using rubber base mixing gun (GC India) and loaded into the block. Standardized impression making technique was performed as described for group I (fig 9).

Study Group IV: After applying a thin coat of adhesive. The one step single mix technique was performed by mixing material using mixing gun (GC India) and the material was loaded into the block and allowed to set as mentioned in group I.

Study Group V: Application of tray adhesive was done and allowed to dry the tray for 5 minutes. The one step mixing impression technique was performed by mixing monophase using Pentamix and loading the material on the block. The impression procedure followed was same as in group I for standardization (fig 10).

After the impression material had set, the impression was gently removed. Surface detail reproduction was evaluated 30 minutes after making each impression stored in room temperature. Continuity of line of duplication was calculated and all the three lines were evaluated for the entire specimen. If at least two of the three parallel lines were reproduced incessantly between cross points, this impression was measured acceptable (fig 11). Impressions were inspected for inaccuracies and voids and were leftover when not found to be acceptable. All impressions were stored in room for 30 minutes prior to pouring with type IV gypsum product.

To homogenize the consequence of the setting expansion of the improved stone, the powder was precisely weighed and the water was dispensed using a measured off container in a ratio of 100 gm/20ml in a mixing bowl. The mix was poured into the impression and was allowed to set absolutely for a day before being removed from the impression. Then dimensional stability was calculated in the model by measuring the distance between the two lines and comparing the distance with the extent of line on metal die used to make the impression. The dimensional stability of these specimens was evaluated by using the travelling microscope.

Evaluation of surface detail reproduction and dimensional stability

Surface detail reproduction was calculated instantly after the impressions were recovered from the stainless steel model. Calculation was attained using two methods. The first assessment was a measurement of the continuity of line duplication according to American Dental Association requirement 19 with a minor alteration. Rather than only calculating the continuity of one of the three parallel lines in two out of three specimens, all three lines were considered for all the specimens. If at least two of the three parallel lines were duplicated incessantly between cross- points, these impressions were measured satisfactory. All others were rated unsatisfactory. (fig 12). This adjustment was made to achieve the power analysis parameters and retain a controllable sample mass. Initial grades from the pilot study shown that even though a quantity of impressions would be rated acceptable for detail reproduction according to the procedure explained above, they revealed surface features such as unevenness, pits, and voids on other areas of the impression.

In clinical conditions, if these limitations were to be found in essential areas, such as preparation finish lines, they would make be the impression undesirable. It was decided that a further assessment of the impressions was essential; as a result, a macroscopic assessment of the impression's smooth surface was incorporated in this study. For this added macroscopic assessment, impressions were rated satisfactory, if the entire impression surface was even, glossy, and free of voids or pits; and impressions were rated as un satisfactory, if the impression surface was uneven or contained any pits or voids.

Dimensional stability was assessed 24 hours after making each impression. A single researcher calculated the length of line two among the cross points x and x' for every impression. This dimension was made three times to the closest 0.001 mm at unique magnification 10 by means of a travelling microscope. The 3 calculated lengths were averaged and compared with the measurement of line 2 on the stainless steel block used to make the impression (fig 13).

Fig:1. Vinyl polysiloxane ether-medium-Identium

Fig:2.Polyvinyl siloxane(Aquasil)

Fig:3. Poly ether Monophase-3m ESPE Impregum

Fig:4. Dispensing the material from pentamix

Fig:5. Stainless steel die

Fig:6. Stainless steel die with 3 horizontal lines

Fig:7 Water bath

Fig:8 Vinyl polysiloxane ether specimen

Fig:9 polyvinyl siloxane specimen

Fig:10 Poly ether specimen

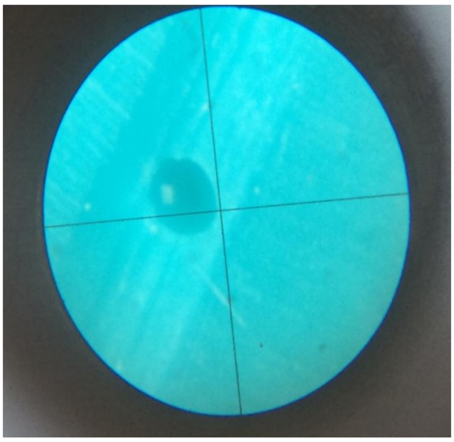


Fig:11 Microscope image of the smooth surface

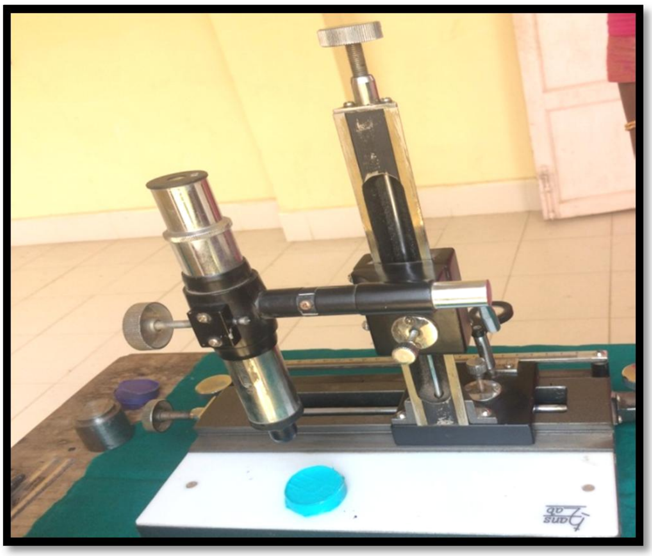


Fig:12 Smooth surface evaluation through travelling microscope

Fig:13 Dimensional stability evaluation through travelling microscope

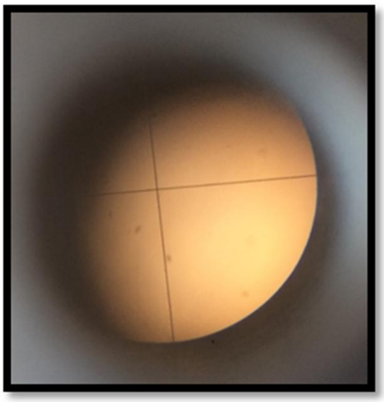


Fig:14 Microscopic image of the Dimensional stability

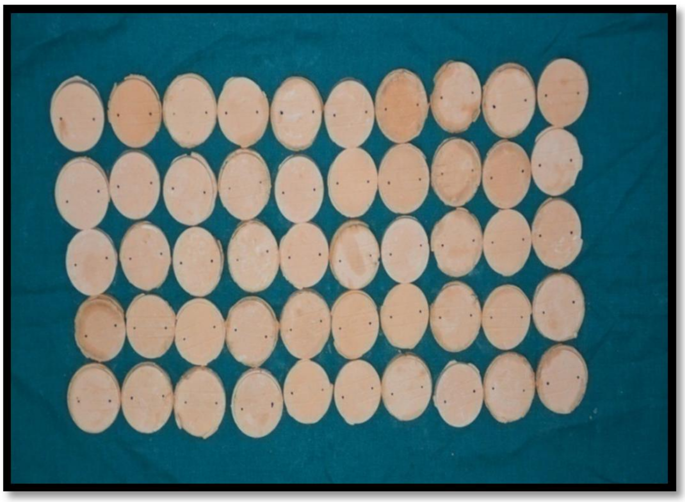


Fig:15 Cast poured out from the impression

Fig16:   DSLR Camera (Nikon D5200 24.1 MP Digital)

RESULTS

STATISTICAL ANALYSIS

This study used a 2-factor completely randomized design. A 2-way analysis of variance (ANOVA) was used to compare the mean dimensional changes of the 5 materials w < .05 level. The least significant difference (LSD) test was used as a post hoc test for pairwise comparisons. Pearson X^2 (< .05) was used to evaluate surface detail reproduction of the 5 materials as determined by criteria alike to American Dental Association requirement 19 and the added smooth surface characteristic assessment.

RESULTS

Impressions made from 5 materials were 100% acceptable, reproducing at least 2 of 3 lines continuously. For this additional macroscopic evaluation, impressions were rated acceptable if the complete impression surface was even, glossy, and free of voids or pits; and impressions were rated as unacceptable if the impression surface was uneven or contained any pits or voids. Pearson x^2 revealed had a statistically significant effect on each material (P<.05). 90% of the light and medium bodied vinyl polysiloxane ether (Identium), and monophase poly ether (Impregum) impressions were acceptable whereas 80% of the light bodied, polyvinyl siloxane (Aquasil) and 70% of the medium bodied, VPS (Aquasil) were found acceptable.

The mean scores for the 5 measurements between cross points x and x' (line 2) in each impression were compared with the line 2 measurement obtained from the metal die used for the impression for the examination of the dimensional stability of five groups. The mean standard deviation and standard error of all the five groups are specified in the table. A 2-way ANOVA was performed to test the significance of the obtained data (table 3). This result indicated that the dimensional accuracy, as given by the American Dental Association specification 19, was not affected. However, statistically significant differences ($p<.05$) were found between the 5 materials. The medium-bodied, vinyl polysiloxane ether (Identium) exhibited less change in dimensional accuracy compared to the light body, vinyl polysiloxane ether (Identium). Mean change of the light bodied, vinyl polysiloxane ether (Identium) was 0.05370 whereas mean change of the medium-bodied, vinyl polysiloxane ether (Identium) was 0.05330. The light body polyvinyl siloxane (Aquasil) exhibited less the change in dimensional accuracy compared to the medium bodied, polyvinyl siloxane (Aquasil) was 0.07150 whereas mean change of the light bodied, polyvinyl siloxane (Aquasil) was 0.06370. The monophase poly ether (Impregum) exhibited less the dimensional accuracy compared to the medium bodied polyvinyl siloxane (Aquasil). Mean change of poly ether was 0.06430. Data for the 5 materials are shown in Table I. All the materials had a significant effect on the detail reproduction (Pearson X^2, $P < .05$).

TABLE 2: PERCENTAGE OF ACCEPTABLE AND UNACCEPTABLE IMPRESSIONS ACCORDING TO CRITERIA BASED ON ADA SPECIFICATION 19 FOR ACCEPTABLE SURFACE DETAIL REPRODUCTION.

			GROUP					Total
			GROUP I	GROUP II	GROUP III	GROUP IV	GROUP V	
PERCENTAGE OF SATISFACTORY AND UNSATISFACTORY IMPRESSIONS ACCORDING TO CRITERIA BASED ON ADA SPECIFICATION 19 FOR ACCEPTABLE SURFACE DETAIL REPRODUCTION.	SATISFACTORY	Count	10	10	10	10	10	50
		% within GROUP	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	UNSATISFACTORY	Count	0	0	0	0	0	0
		% within GROUP	0%	0%	0%	0%	0%	0%
Total		Count	10	10	10	10	10	50
		% within GROUP	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table no :3 ADDITIONAL SMOOTH SURFACE EVALUATION

			GROUP					Total
			GROUP I	GROUP II	GROUP III	GROUP IV	GROUP V	
PERCENTAGE OF SATISFACTORY AND UNSATISFACTORY IMPRESSIONS ASSESSED WITH ADITIONAL SMOOTH SURFACE EVALUATION	SATISFACTORY	Count	9	9	8	7	9	42
		% within GROUP	90.0%	90.0%	80.0%	70.0%	90.0%	84.0%
	UNSATISFACTORY	Count	1	1	2	3	1	8
		% within GROUP	10.0%	10.0%	20.0%	30.0%	10.0%	16.0%
Total		Count	10	10	10	10	10	50
		% within GROUP	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table No: 4 COMPARISONS OF MEAN VALUES WITHIN THE GROUP FOR DIMENSIONAL STABILITY

	N	Mean	Std . deviation	Std . error
Group 1 VPSE (light)	10	.05370	.011691	.003697
Group 2 VPSE (medium)	10	.05330	.003917	.001239
Group 3 VPS (light)	10	.06370	.016573	.005241
Group 4 VPS (medium)	10	.07150	.008734	.002762
Group 5 PE (monophas)	10	.06430	.014469	.004575
Total	50	.06130	.013414	.001897

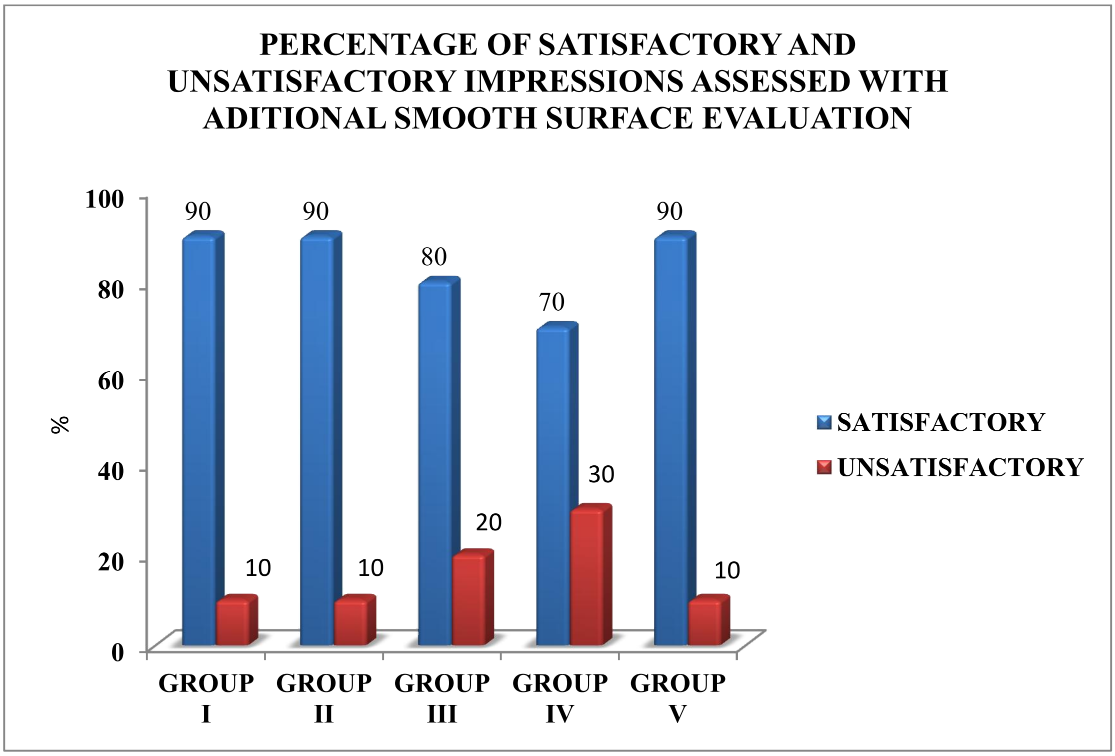
Table No: 5 STATISCAL EVALUATIONS FOR DIMENSIONAL STABILITY

	Sum of squares	df	Mean square	F	Sig
Between group	.002	4	.001	4.221	.005
Within group	.006	45	.000		
Total	.009	49			

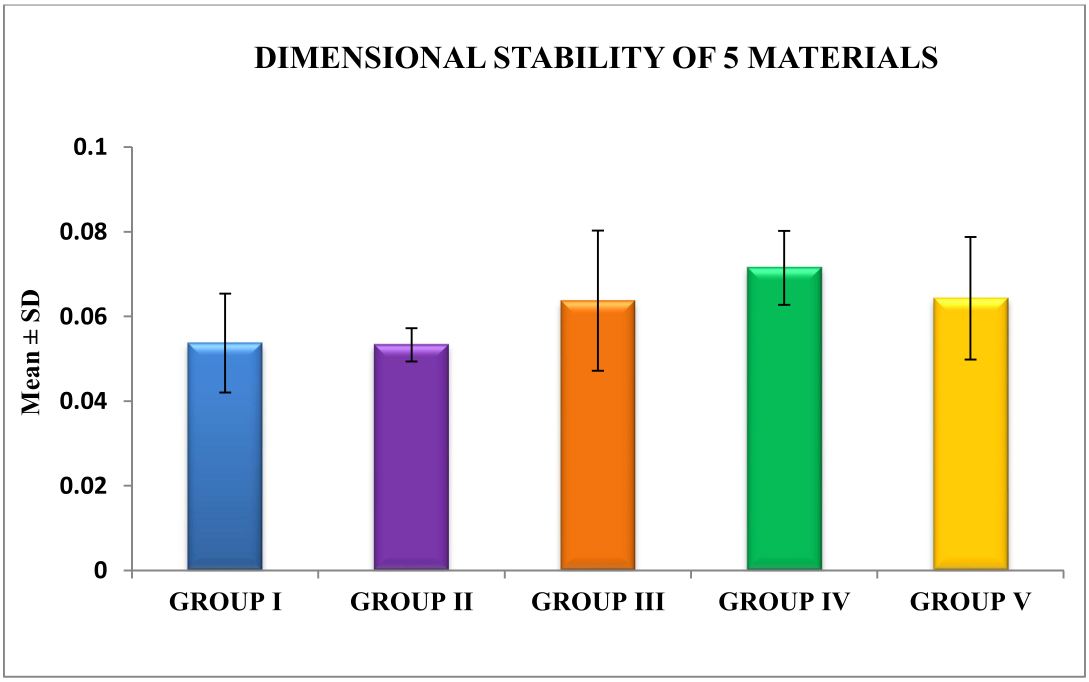
Table No: 6 POST HOC TEST FOR DIMENSIONAL STABILITY

Materials	Material	Mean differance	Std . error	Sig .
GROUP I	**GROUP II**	.000400	.005338	1.000
	GROUP III	-.010000	.005338	.346
	GROUP IV	-.17800	.005338	.014
	GROUP V	-.010600	.005338	.289
GROUP II	**GROUP I**	-.000400	.005338	1.000
	GROUP III	-.010400	.005338	.308
	GROUP IV	-.018200	.005338	.011
	GROUP V	-.011000	.005338	.255
GROUP III	**GROUP I**	.010000	.005338	.346
	GROUP II	.010400	.005338	.308
	GROUP IV	-.007800	.005338	.592
	GROUP V	-.000600	.005338	.663
GROUP IV	**GROUP I**	.017800	.005338	.014
	GROUP II	.018200	.005338	.011
	GROUP III	.007800	.005338	.592
	GROUP V	.007200	.005338	.663
GROUP V	**GROUP I**	.010600	.005338	.289
	GROUP II	.011000	.005338	.255
	GROUP III	.000600	.005338	1.000
	GROUP IV	-.007200	.005338	.663

Graph: 1


PERCENTAGE OF SATISFACTORY AND UNSATISFACTORY IMPRESSIONS ASSESSED WITH ADITIONAL SMOOTH SURFACE EVALUATION
100
80
60
40
20
0
%
90
90
80
70
90
10
10
20
30
10
GROUP I
GROUP II
GROUP III
GROUP IV
GROUP V
SATISFACTORY
UNSATISFACTORY

Graph No: 2


DIMENSIONAL STABILITY OF 5 MATERIALS
Mean ± SD
0.1
0.08
0.06
0.04
0.02
0
GROUP I
GROUP II
GROUP III
GROUP IV
GROUP V

DISCUSSION

A discussion on the basic requirements of impression materials can be approached from four main angles. On one hand, it deals with factors that influence the dimensional accuracy of the impression; on the other hand are parameters that impact the dimensional stability. Furthermore, for example, the handling and setting characteristics of the impression material, as well as other variables such as cost, taste, and color, play a role. Recent development and advances has led to introduction of newer impression materials, which claim to be better and with more clinical applications than the conventional elastomeric impression material. Most common clinically used impression material polyvinyl siloxane has proven to have good dimensional accuracy but it lacks in tear strength, while poly ether has proven to have best tear strength of all the elastomeric impression material. A new impression material which is a blend of both the positive properties of addition poly siloxane and polyether has been developed which has better tear strength than additional poly siloxane. There is no available literature that claims the dimensional stability and accuracy of the newly formulated vinyl polysiloxane ether , hence more study needs to be done to evaluate and compare the dimensional stability and accuracy of newly formulated vinyl polysiloxane ether impression material with other conventional elastomeric impression material The purpose of the current study was to evaluate and compare the dimensional stability and accuracy of three elastomeric impression materials namely poly ether, polyvinyl siloxane and vinyl polysiloxane ether by comparing the dimensional stability of working casts formed from master model.

Markus B et al [6], the use of metal tray are one of best in regarding the dimensional accuracy and reliability of impression making. Impression taking with disposable plastic stock trays (DiTs) is becoming increasingly popular for daily impression procedure. Rising awareness of the need to prevent cross contamination and save time when cleaning and sterilizing are possible reasons.

The use of DiTs, however, may affect the dimensional accuracy of impressions due to elastic rebound during impression taking, especially when putty viscosities are used.

Carrotte el al [7], stated that the impressions made with flexible plastic trays produced considerable discrepancies due to flexibility of the tray under heavy impressions. Custom trays provide uniformity of materials which minimize the dimensional changes that might distort an impression.

Gilmore et al [8] explained that when compared with stock trays the use of customs tray produced dies were much more accurate. Glen Johnson[9] stated when compared with stock tray, the dimensional accuracy of the impressions in the custom tray was found to be more accurate in the vertical dimension. When addition silicone impressions were used the dimensional accuracy was same with putty/wash, single mix and double mix techniques when they used perforated custom made trays, the most replicative impression and resultant die were found with full adhesive application**.** In this study we used a standardized definitive model with stainless steel base is fabricated and each specimen was made using a stainless steel mold.

Bomberg et al[10] stated that to minimize marginal opening the use of full application of adhesive and the use of perforated trays were one of the important factor. The use of stock or custom trays and the use of the putty/wash or single-mix technique had no significant effects on the observed marginal opening. So tray adhesive sponsored by the company was applied to the surface of the stainless steel custom made block and allowed to dry for five minutes before loading the impression in the block.

De Araujo et al [11] assessed the effect of bulk of the material and undercuts on the dimensional accuracy of impression materials. He found out that a greater distortion was caused with increase in thickness of the impression material from 1 to 4 mm. As the thickness of the material increased, dimensional accuracy decreased and so the material should be uniform all over the surface. All impression materials were mixed according to the manufacturer's directions by using, where required, clean dispensing automix gun. No attempts were made to dispense by weight. Each specimen was made from a separate mix. The catalyst and base components from the manufacturer were supplied in a self mixing apparatus consisting of two cylinders of impression mater, a static mixing nozzle and a ratchet extrusion device. This material was mixed in the manner specified by the manufacturer. The cartridge was bled in conformity with manufacturer's advice to make certain appropriate dispensing ratios. The material was weighed down into a fine-tipped impression syringe and applied to the ruled areas of the stainless steel block. The impression material was pressed in advance of the syringe tip. This technique gives way the smallest number of voids as made known in the pilot study.

Craig et al [12] suggested that automixing suggested that the use of automixing tips was important because of its simplicity, convenient to use, cost effectiveness, no spatulation and consistent mix. Chee et al [13] stated that the uses automixing system reduced the number of bubbles incorporated in the mix for all the impression materials, 3MESPE automix machine with tips were supplied by the manufacturer. Impression technique can be monophase and dual phase.

The monophase technique was a single step in a single-step procedure, using materials with a medium viscosity to allow the material itself to record the finer details while avoiding the slumping of the material in the tray, it is economical, less time consuming and simple to perform. Specially made plastic molds were placed on the beveled ends of all die, to enclose the material and make sure a constant thickness of 3 mm.

Tjan et al [14] stated that when custom trays were used with full adhesive application the most replicative impression and resultant die were found in a single mix technique. When compared the original stainless steel die the single step technique resulted in slightly larger dies, while the 2-step technique produced significantly smaller dies, without relief. Either poly ether or vinyl polysiloxane ether with the single-step technique no significant differences were observed in dies.

Hassan AK et al [15] carried out a study to measure changes in silicone impression materials which can affect fitness of prosthesis. Single mix gave more accurate casts than double mix technique. Techniques that use dual-phase materials such as the putty/heavy and light-body wash method may be accomplished in 1 or 2 steps (single mix single step and double mix single step impression techniques). Both the techniques were found to be accurate and not significantly different from each other. Surface detail reproduction was evaluated immediately 30 minutes after the impressions were recovered from the dies. Dimensional stability was calculated 24 hours after making all impression. A single researcher calculated the length of line 2 between cross points x and x' for every impression. These dimensions were made 3 times to the nearest 0.001 mm at unique magnification 10^X using a travelling microscope.

In most of the studies reported in literature so far, precision measurement was done using instruments such as travelling microscope, micrometer, vernier caliper, and laser probes. In the present study, a travelling microscope (ELFO, INDIA) was used. It had a least count of 0.01mm, fitted with a10^X magnification. This study was carried out to compare the dimensional stability of consequential models made of improved stone from polyvinyl siloxane, poly ether and the vinyl polysiloxane ether elastomeric impression material correspondingly. Chandur et al[18] stated that the working casts and working dies from regular and fast-setting poly ether demonstrated an increase in all dimensions when compared to the master model and stainless steel complete crown preparation. The working casts from the fast-set polyvinyl siloxane were larger than the master model, whereas working dies showed a reduction in mesiodistal dimension and height compared to the stainless steel complete crown preparation. The new fast-setting poly ether and polyvinyl siloxane materials demonstrated dimensional accuracy equivalent to a traditional poly ether. In our study the addition of poly ether improved the dimensional stability of the material of the newer material.

Shilling burg et al [20] stated that polyvinyl siloxane impression materials are extremely precise when used in clinical dental practice. The dimensional stability of a material was typically time reliant; Dentists have been reported to delay pouring of impressions up to 72hours; therefore, it is important that an impression material should remain dimensionally accurate for this stage of time. Polyvinyl siloxane impression materials have demonstrated finer dimensional stability when evaluated with other elastomeric materials, principally because they do not discharge any by-products. Both the polyvinyl siloxane materials showed good dimensional stability over time period of the study. In our study when compared with polyvinyl siloxane and poly ether, newer hybrid material was dimensionally more stable.

Goncalves et al [34] sugessted that polyvinyl siloxane was more stable even after 4 weeks when compared to polyether which had a dimensional stability only within 24 hrs. In our study vinyl polysiloxane ether, showed good dimensional stability when compared with polyvinyl siloxane & poly ether so further studies can be done regarding the dimensional stability of the material once a long period of time following mixing. Techkouhie et al [35] suggest that polyvinyl siloxane has better dimensional stability when compared to polyether. In our study vinyl polysiloxane ether was found to be dimensionally stable than vinylsiloxane & poly ether.

Seyedan et al [36] stated that vinylsiloxane and poly ether showed no significant difference when tested for accuracy in implant impression. In our study vinylsiloxane and poly ether showed no significant was found.

Petrie et al [25] stated that the dimensional stability for both hydrophilic polyvinyl siloxane impression materials was not considerably affected by the dry, moist, or wet atmospheres. There was a statistically considerable difference in the dimensional stability between the two polyvinyl siloxane materials. However, dimensional changes for both materials were well below American Dental Association values of maximal shrinkage value of 0.5%. Both materials tested acceptably with respect to detail reproduction under dry and moist conditions, but not in wet conditions. In this study, dimensional stability and accuracy was superior for vinyl polysiloxane ether than poly ether and polyvinyl siloxane. Measurements of casts obtained from all five groups showed slight increase in dimensions. However, when these changes in dimensional stability were compared with American Dental Association requirement 19, all the materials revealed satisfactory dimensional stability, well below0.5% dimensional change. Surface detail reproduction was first assessed based on the criteria similar to American Dental Association requirement 19 (2 of the 3 parallel lines were reproduced continuously between cross-points).

Although these differences when compared to the master die were significant, such a small discrepancy between the five groups of casts obtained from the different study group in relation to the overall dimensions might be considered clinically insignificant. The new vinyl polysiloxane ether impression material showed good surface detail reproduction and dimensional stability among all five study groups.

The null hypothesis that no dissimilarity would be in the dimensional stability and surface detail reproduction of casts fabricated with the different viscosity of elastomeric impression materials was rejected since there are significant differences among the five groups. In the majority of situations, the differences detected were minute in magnitude and of slight clinical consequence.

SUMMARY

Development of material science has allowed integrating qualities of poly ether and polyvinyl siloxane into a newer hybrid material vinyl polysiloxane ether. The aim of this study is to compare the newer material vinyl polysiloxane ether with the poly ether and polyvinyl siloxane in terms of accuracy and dimensional stability.

Stainless steel dies with American Dental Association specification 19 was made. Die has 3 parallel and 2 perpendicular lines are used for impression making.. The parallel lines are labeled 1, 2, and 3. The width of the parallel line is 0.60 mm. Two cross-points at the intersection of the perpendicular lines with line 2 were marked *x and x' and served as the beginning* and end points of measurements for dimensional stability. Accuracy was evaluated 30 minutes after making each impression stored in room temperature.Continuity of line of duplication is measured. If at least 2 of the 3 parallel lines were reproduced constantly between cross points, this impression was considered acceptable. The specimens are poured with type IV gypsum product and allowed to set completely for 24 hours. Then dimensional stability was measured in the model by measuring the distance between the two lines and comparing the distance with the measurement of line on metal die used to make the impression.

The mean value obtained for the vinyl polysiloxane ether light was 0.05370 and for medium was 0.05330. the mean value for light and medium bodied polyvinyl siloxane was 0.06370 and 0.07150 and the mean value for poly ether monophase was 0.06430 respectively. A 2-way ANOVA statistical analysis gave a significance of p=0.005 while the post- hoc test for inter group analysis gave a p value of > 0.05. The new vinyl polysiloxane ether material showed good surface detail reproduction and DS among all five study groups.

Although these differences when compared to the master die were significant, such a small discrepancy between the five groups, in relation to the overall dimension can be considered clinically insignificant.

CONCLUSION

This invitro study was conducted to evaluate and compare the **surface detail reproduction and dimensional stability of poly ether, polyvinyl siloxane and vinyl polysiloxane ether impression material .**Within the limitations of the study the following conclusions were drawn:

1. The new vinyl polysiloxane ether impression material showed good **surface detail reproduction and dimensional stability** among all five study groups.
2. Poly ether showed better surface detail reproduction and dimensional stability when compared with polyvinyl siloxane.
3. Polyvinyl siloxane showed poor dimensional stability when compared with the newer hybrid material vinyl polysiloxane ether and poly ether.
4. Measurements of casts obtained from all five groups showed slight increase in dimensions.
5. Although these differences when compared to the master die were significant, such a small discrepancy between the five groups of casts obtained from the different study group in relation to the overall dimensions might be considered clinically insignificant.

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Dated 09-11-1993

Affiliated to
The Tamil Nadu Dr.M.G.R.
Medical University, Chennai

This ethical committee has undergone the research protocol submitted by **Dr.SHYMA ROSE. P.D**, Post Graduate Student, **Dept of Prosthodontics And Crown & Bridge** under the title **"comparative evaluation of surface detail reproduction and dimensional stability of poly ether, Polyvinyl siloxane and vinyl polysiloxane ether impression materials - an invitro study "** under the guidance of **Dr.*A.Shyam Mohan, MDS, DNB*** for consideration of approval to proceed with the study.

This committee has discussed about the material being involved with the study, the qualification of the investigator, the present norms and recommendation from the Clinical Research scientific body and comes to a conclusion that this research protocol fulfills the specific requirements and the committee authorizes the proposal.

Dr. I. PACKIARAJ MDS
CHAIR PERSON
Ethical Committee

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