

Comparative Analysis of Dimensional Accuracy of Vinylsiloxane Ether, Polyvinylsiloxane and Extended Pour Alginate Impression Materials- An in Vitro Study

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Abstract

Original Research Article

Aim: Aim of the study was to evaluate dimensional accuracy of new material vinylsiloxane ether and compare with polyvinylsiloxane and extended pour alginate. **Materials & Methodology:** A stainless steel die with two tapered abutments with cross grooves on occlusal surface for reference measurement was fabricated on a lathe. Total thirty samples were made, ten samples from each three study group and poured using Type IV gypsum product. Travelling microscope was used to assess various dimensions. One-way ANOVA test, Tukey's HSD and 't' test were used for statistical analysis. **Results:** Showed that casts yielded for all the study groups were bigger in dimensions. Vinyl siloxanether impression material yielded minimum percent deviation from control and most accurate casts. All three impression materials yielded clinically acceptable results. **Conclusion:** Within the limitations of this study, it was concluded that vinyl siloxanether impression material yielded more accurate impressions. Although, statistically significant differences were observed among the three groups it can be concluded that the overall accuracy of all the casts obtained was high. **Clinical Significance:** Conventional fixed prosthodontic treatment demands accuracy of prosthesis as it is the prerequisite for long term success of the treatment. It mainly depends on fit of the prosthesis which in turn depends on the dimensional accuracy of dies poured from elastomeric impression materials.

Keywords: Accuracy, elastomers, alginates, impression, travelling microscope.

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INTRODUCTION

Dentistry is the "horizon" for mankind where beauty meets science, embracing physical, psychological values of individualized patient. It merges artistic ability and technical competence to meet the aesthetic demands of the patient, wherein various features of the face, smile, teeth and gums complement each other naturally.

Accurate replica of the patient's hard and soft tissue with impression materials plays an important role in obtaining biologically, mechanically, functional and aesthetically acceptable restorations [1]. Impression making is an important step in the complex process of fabricating a well fitting indirect prosthesis.

An ideal impression material should encompass many features, including demonstration of excellent detail reproduction, good tear strength and no distortion on removal from mouth. It must be

biocompatible, non-toxic and have an acceptable odour and taste. A long working time, short setting time and a long shelf life are all desirable features. An ideal impression allows multiple pours and disinfection/infection control without losing accuracy. No impression material meets all of these requirements, but significant improvements have been made over years [2].

Inaccuracy during impression making is difficult to correct in subsequent steps and influences marginal fit and occlusal precision of the restoration. Thus, an incorrect impression requires repetition of the impression and worst, the re-fabrication of the restoration.

Dimensional accuracy and dimensional stability of impression materials have been the traditional goals of researchers and clinicians. According to American Dental Association (ADA)

specification #19, ISO 1563:1990E for elastomeric impression materials and ADA specification no. 18, ISO 4823:1992E for alginate impression materials, are used to fabricate precision castings and must be able to reproduce fine details of 25 micron meter or less [3].

Polyvinyl siloxane impression materials have been in the market since mid 1970s. It has the best fine detail reproduction and elastic recovery. They are available in wide range of viscosities, rigidities and working and setting times, so they can be used in majority of clinical situations.

The popularity of Polyvinyl siloxane impression material in fixed prosthodontics and implant dentistry in unparalleled, despite being expensive, surpassed by combination of the excellent accuracy, handling characteristics and unlimited dimensional stability [4]. The hydrophilization of polyvinyl siloxane is enhanced with incorporation of certain non-ionic surfactant.

Vinyl siloxanether impression material is addition curing elastomer, with parts of polyvinyl siloxane and polyether, is available commercially. Vinyl siloxanether, available in three viscosities heavy bodied, medium body and light bodied, convinces the clinician with excellent flow and hydrophilic properties, high tear strength, dimensional accuracy and resistance to permanent deformation [1].

The nano-silicone and sialanized micro quartz fillers and triglycerides provide a thermo sensitive 3-D network, which ensure processing over an extended period of time.

The filler system warrants optimum thixotropy. Under pressure flows into the smallest structures, thanks to the nano-silica agglomerates that constitute the 3-D network, which dissolve under pressure (shearing). It has remarkable hydrophilicity ensures an optimal inflow in a humid environment, even in the narrowest sulcus crevices [5].

Hydrocolloids impression materials-irreversible (alginate) are most commonly used for impression making because of their ease of use and economical concerns [6]. But they possess very low tear strength and need to be poured immediately after impression making. Newer alginate, if stored at 100% relative humidity, retain accuracy over 24 hours that was equivalent to that of the elastomers. More recently, the manufacturer of extended pour alginate claim equivalent dimensional accuracy and stability to the elastomers for up to 100 hours [7].

The study was undertaken to evaluate and compare the dimensional accuracy of Vinyl siloxanether, Polyvinyl siloxane and Hydrogum 5.

MATERIALS AND METHODOLOGY

In the study a two abutment stainless steel die with ADA sp. No.19 and stainless steel perforated metal trays were fabricated.

	Dimensions	Mm
A	Diameter of abutment at base	7.40
B	Diameter of abutment at apex	6.50
C	Height of abutment	8.10
D	Inter-abutment distance	28.85
E	Width of finish line	0.40

Impression Making and Grouping: Ten impressions per group were made using the Vinyl siloxanether, Polyvinyl siloxane and Hydrogum 5 impression materials.

Measurement: Measurements for the master model as well as the all stone models were made by travelling microscope having accuracy of 0.01 mm and 10X magnification.

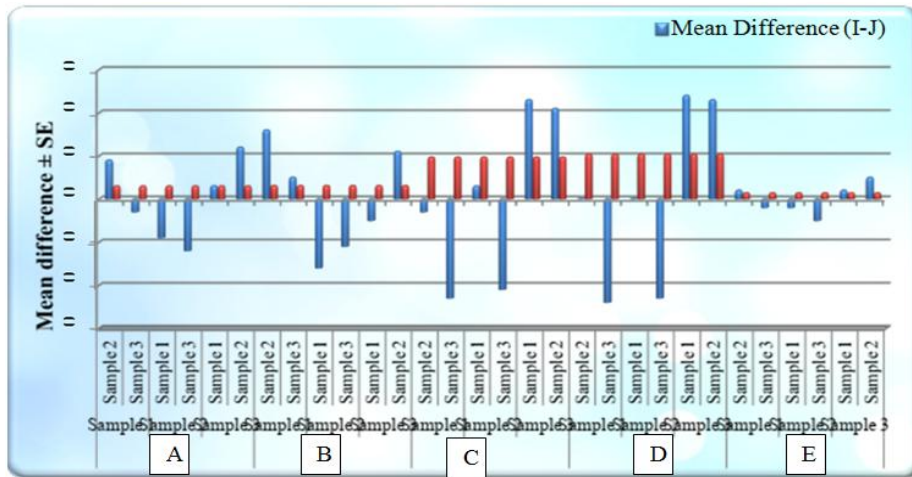
Exclusion Criteria: Defective impression and gypsum models with voids and distortion were discarded.



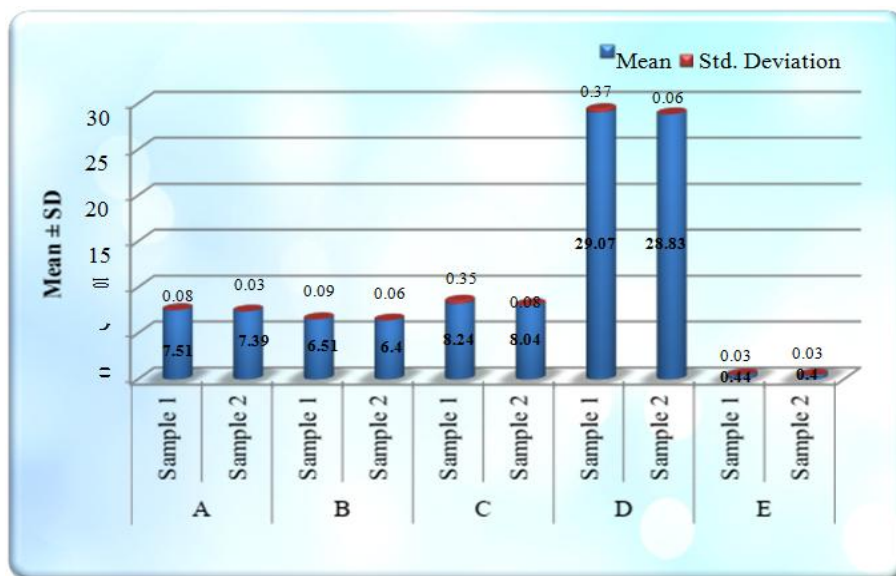
Pentamix 3 3M ESPE loaded with cartridge

RESULTS

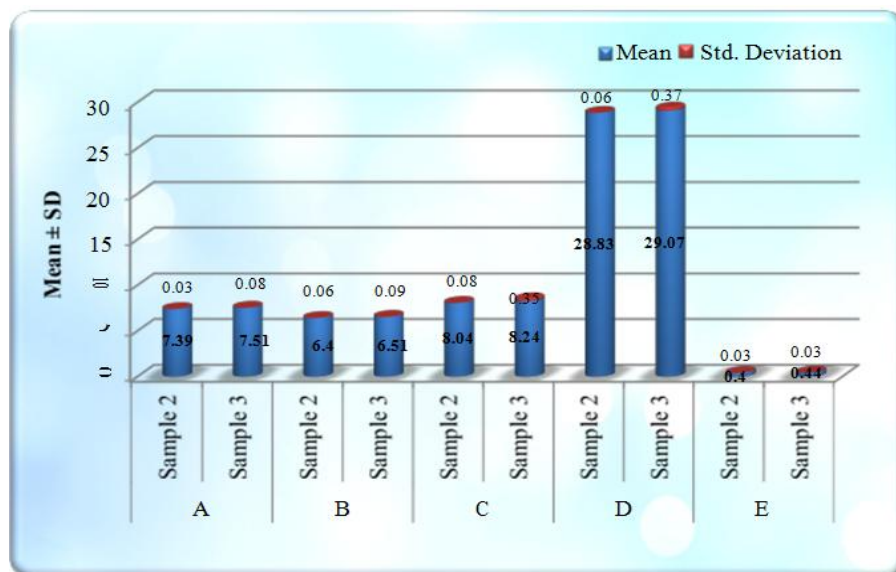
In the study, the dimensional accuracy of stone models using addition silicone, vinyl siloxanether and hydrogum 5 were investigated. Measurements were made to record five dimensions namely A, B, C, D, E in order to evaluate and compare the dimensional accuracy.



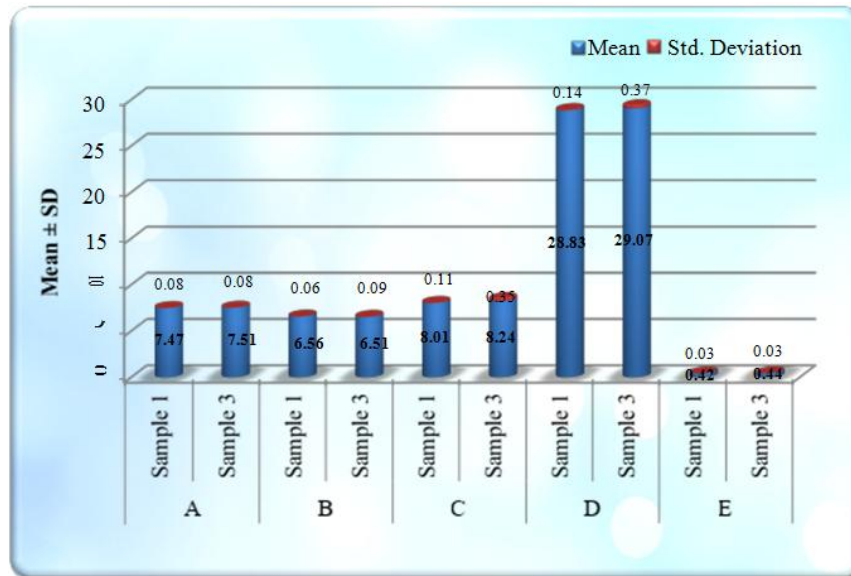
Post Hoc pair wise comparison between different samples at various dimensions (Tukey's HSD Test)



Comparison between sample 1 and sample 2 with different dimensions



Comparison between sample 2 and sample 3 with different dimensions



Comparison between sample 1 and sample 3 with different dimensions

DISCUSSION

The purpose of the study was to evaluate and compare dimensional accuracy of Vinyl siloxanether, Polyvinyl siloxane and Hydrogum 5 impression materials.

An accurate impression constitutes the primary requirement for well fitting prosthesis. The impression material used must necessarily register the finest details of teeth and supporting tissues because the prosthesis can be no more accurate than the impression for which it is made. Dimensional accuracy hold the key for futuristic prosthesis [8]. As duplicate casts are usually required for various laboratory procedures e.g. design connectors of fixed partial denture and fabrication of wax patterns [9].

The factors affecting accuracy of impression can be classified as follows:

A. Factors under the complete control of the practitioner:

- Selection of impression material
- Selection of impression techniques

Proportioning, mixing and loading the material into an adhesive coated tray and seating in the patient's mouth.

B. Factors under the limited control of practitioner:

- Degree of distortion on removal from mouth
- Storage conditions of the set impression
- Duration of storage prior to the preparation of a model or die

C. Unavoidable manipulation factor

- Thermal contraction on cooling from mouth to room temperature
- Dimensional changes due to setting process

D. Unknown factors

- Degree of constrains exerted by the impression material on setting reaction.

The properties of the impression materials also exert an influence on the clinical acceptability of impression [10]. Some of the factors involved in choosing a material are accuracy, dimensional stability, working time, shelf life, electroplating capability and taste.

The major types of elastomeric impression materials used to record impressions are Polysulfides, Condensation silicones, Addition Silicones and Polyethers, Vinyl siloxanether is a newer impression material introduced in market and irreversible hydrocolloids—conventional alginate and extended pour alginate are used on a routine basis [11].

Addition polysilicones are suitable for fixed and removable partial denture impressions. These differ from condensation silicones as there is no alcohol by product resulting from polymerizing reaction and hence no shrinkage occurs. The impressions are dimensionally stable and can poured at convenience of the operator [12].

Irreversible hydrocolloids are one of the several impression materials that are commonly used in the dental office to produce stone casts. Ease of use, low cost integrated with good clinical and physical properties make alginate a popular choice among variable dental practices. Extended pour alginates maintained dimensional accuracy and stability when stored adequately up to 5 days [13]. They are also compatible with the Type IV gypsum products, which is the most common die materials used [14].

The structure of hydrocolloids, a large part of the gel volume is occupied by water. If the water content of the set gel changes, the volume will shrink or expand, affecting dimensional accuracy and stability. The gel may lose water by evaporation from its surface, or by syneresis (exudation of fluid onto the surface). Syneresis is macroscopically characterised by a slow, time-dependent, “de-swelling” (shrinkage) of a gel, resulting in an exudation of liquid. It is a phenomenon commonly observed over time undergoing a sol/gel transition [5].

Various factors affecting accuracy of impressions like selection of the impression material, impression techniques, proportioning, mixing and loading the material into an adhesive coated tray and seating in the patient mouth, these various factors are under the control of dentist.

According to ADA specification no.19 elastomeric impression materials used to fabricate precision castings must be able to reproduce fine detail of 25 microns or less. Among the elastomeric impression materials poly vinylsiloxane impression materials are highly popular because of their physical properties, dimensional stability and ability to reproduce a highly accurate replica of oral structures.

To assess dimensional accuracy of polymeric impression materials, ADA specification No. 19 prescribes a stainless steel die with linear pattern inscribed. The evaluation of dimensional changes carried out by comparison of dimensional changes between stone cast made from impression of the die and master die [13].

In this study, dimensional accuracy of a commercially available polyvinyl siloxane Aquasil (Dentsply), monophase which is a hydrophilic polyvinyl siloxane impression material was compared with vinyl siloxanether impression material (Identium, Kettenbach) and irreversible hydrocolloid Hydrogum 5. Vinyl siloxanether impression material is essentially a combination of polyether and addition silicone [14]. Hence the clinician has advantages of the addition silicone and polyether. This material has been said to possess good mechanical and flow properties along with excellent wetting characteristics in the unset condition. Hydrogum 5 maintain their dimensional accuracy and stability over a prolonged period of time [15].

The various methods used to determine the accuracy of impression include-

Vinyl siloxanether impression materials gave more accurate casts when compared to the other impression materials. This could be related to the composition of this newer material which is intended to incorporate the natural hydrophilicity of conventional polyether materials along with the desirable properties

of addition polysilicone materials, such as elastic recovery and tear resistance [5]. To further improve the wetting characteristics and flowability, a surface tension eraser (STES) and wetting conditioner surfactant (WCS) have been incorporated into vinylsiloxanether, as per the manufacturer. This result also coincides with the study done by Thomas Stober [1].

The results of the present study may be useful to the clinicians when selecting impression material. Further study should be done on the biological, rheological and wetting properties of elastomeric and hydrocolloid impression materials in order to ascertain their equivalence for clinical acceptability.

The difference detected was small in magnitude and of minor clinical significance. Dimensional accuracy of impression materials is a primary basis for all successive treatment steps [16].

SUMMARY

Making an impression represents a crucial step in processing and fitting dental prosthesis. The elastomeric and irreversible hydrocolloid impression materials are the most commonly used materials.

The present in vitro study was conducted to evaluate and compare dimensional accuracy of poly vinylsiloxane, vinyl siloxanether elastomeric impression materials and hydrogum 5 irreversible hydrocolloid impression material.

To test the dimensional accuracy, a stainless steel model was fabricated with two tapered abutments according to the ANSI/ADA Specification No. 19. The abutments were of equal size with cross reference grooves which facilitated the measurements. Impressions were made in perforated metal custom tray. The perforations provided for retention of the impression materials and also facilitated the escape of excess impression material thereby preventing hydraulic pressure from being built up during the seating of impression tray. Tray adhesive was applied and allowed to dry. The impression materials were manipulated according to manufacturer's instructions.

A total of thirty impressions were made of the stainless steel model. Impressions were poured with type IV gypsum product. The dimensions measured were diameter of abutment at apex and base, height of abutment, finish line width and inter-abutment distance.

Measurements were carried out using a travelling microscope, having an accuracy of 0.01mm. The data was tabulated and subjected to statistical analysis. One-way ANOVA, unpaired t-test and post-hoc Tukey's HSD tests were used to compare the dimensional change between the casts of all study groups.

Measurements of casts obtained from all three groups showed slight increase in dimensions. Although these differences when compared to the master die were significant. Such a small discrepancy between the three groups of casts obtained from the different study group in relation to the overall dimensions might be considered clinically insignificant. Vinyl Siloxanether impression material showed good dimensional accuracy among all three study groups.

CONCLUSION

Within the limitations of this study, it was concluded that vinyl siloxanether impression material resulted in more accurate casts.

- The medium body vinyl siloxanether impression material yielded more accurate results than those of addition silicone elastomeric and irreversible hydrocolloid impression material.
- The medium viscosity of polyvinyl siloxane i.e. addition silicone elastomeric impression material and hydrocolloid 5 irreversible hydrocolloid resulted in casts that were less accurate but clinically acceptable.
- Although some statistically significant differences were observed among the three groups, it can be concluded that the overall accuracy of all the casts obtained was high.

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Conflict of interest: None

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