

Original Article

A Comparative Study on Accuracy and Reproducibility of Alginate and Addition Reaction Silicone as an Impression Materials.

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ABSTRACT

Background: To achieve accuracy and exact reproduction of prosthesis, choosing a perfect impression material is essential. Especially to make the prosthesis as accurately as possible, impression material should possess some essential properties, like; minimum dimensional changes, good flow ability and easy removal. **Purpose:** The aim of this study was to evaluate the accuracy and surface detail reproduction of Alginate and Addition Reaction Silicone as an impression materials. **Method:** This is an experimental in vitro study. In this study Impression by Alginate and Addition Reaction Silicone were made using a round stainless steel test block with three horizontal lines and two vertical lines. The horizontal lines were used for evaluating the surface detail reproduction, and vertical lines were provided for the dimensional accuracy. For dimensional accuracy the length of the middle horizontal line in between vertical lines and the distance between the top and bottom horizontal line was measured using travelling microscope. And for surface detail reproduction three horizontal line of one segment were observed under stereomicroscope. **Result:** According to study results Addition Reaction Silicone is better than Alginate regarding quality of impression. **Conclusion:** In comparison to Alginate, Addition Reaction Silicone might have better performance about accuracy and surface detail reproduction.

Introduction:

Impression material is used to record the intraoral structure. Ideally the material should be extremely accurate, and virtually distortion free. The accuracy allows to record minute details without taking additional impression.

The material is very soft elastic, & resistance to tear while removes from the undercut¹.

Clinically, there are many kinds of impression materials available for dental use. Generally, they can be divided into two large groups: (1) Synthetic elastomeric impression materials that include Polysulfide, Condensation Silicone, Addition Silicone and Polyether. Silicone impression materials are the most acceptable in this group. (2) Hydrocolloid impression materials, this group includes Agar Agar and Alginate impression materials, the latter being

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more popular. Clinicians are not agreed which of these two groups is better but, because Alginate is cheaper than other materials, it is hoped that it may become the material of choice.

Accurate impression of is important for the success of removable metallic fixed and implants prosthesis. The properties of impression materials are responsible for reproducing the surface accurately and dimensionally stable as well.

An accurate refractory cast may be obtained when an impression of the original cast is made in a material with elastic property & poured with investment.

The most important characteristics of impression material include high accuracy, exact reproduction of details, controllable dimensional changes, good flow ability and easy removal and handling.

Several types of impression materials are available in dentistry. Every material has some strength and limitation. Alginate is one of the most frequently used dental impression materials. It is an elastic irreversible hydrocolloid and is used for study casts, master casts and working models for the fabrication of intraoral appliances^{2,3}.

It is also used for creating the opposing model for crown & bridge, It is hygienic, inexpensive, does not lose surface detail in wet mouth ,simple cost effective, form an inseparable part of indirect restorations⁴. But it has many shortcomings as an ideal impression material⁵. This material does not readily flow into areas in which the tray does not extend. If distortion occurs, it cannot be corrected.

Alginate is supplied both as powder and paste form. The most popular form of Alginate is supplied as a powder, which is mixed with water. Many Alginates are supplied with a reaction indicator that changes color of the impression when the material is set; and presently, dustless Alginates are preferred. Powder may be available in bulk form in containers or in individual sealed pouches. Paste form is available in two viscosities, tray and syringe viscosities. The paste-type material has a

shorter gelation time than the powder-type material. The best surface quality can be obtained with the paste-type material⁴.

The Elastomeric impression material was developed as an alternative to natural rubber during World War II. These materials have since been modified chemically and physically for use in dentistry. Initially, this group consisted exclusively of Polysulfide impression materials. Subsequently, Condensation-cured Silicones were developed.

Today the most popular Elastomers used in dental practice are the Polyethers and Addition-Reaction Silicones, or Vinyl Polysiloxanes⁶. Elastomeric impression materials are often used to reproduce soft tissues, the dental arch, and teeth which have been prepared for indirect laboratory restorations. There are many commercially available products which fulfill criteria such as nontoxicity, ease of handling, appropriate accuracy, good detail reproduction and dimensional stability¹.

Addition Silicones (Polyvinyl Siloxanes) have a moderately low-molecular weight Silicone that contains silane groups. Since Addition Silicones do not produce a volatile by-product during polymerization, very small dimensional changes occur on setting. Hydroxide groups in many products produce hydrogen gas, resulting in small bubbles on the model surface if pouring is not delayed by 30-60 minutes. Many of these Addition Silicones contain catalysts like palladium that absorb this hydrogen. Newer Addition Silicones have been formulated to be more hydrophilic⁷.

The advantages of Addition Silicones are that multiple casts can be made from a single mold and it is possible to wait for an extended period of time before pouring the mold with the investment materials. They are considerably more expensive to use but are preferred by some laboratories for making multiple casts from same mold.

Compared the accuracy of Alginate and Elastomeric impression materials⁸. They found that Alginate impression materials had a degree of accuracy comparable with other elastomeric impression materials.

This study is aimed to compare the impression materials in terms of accuracy and detail reproduction between Alginate and Addition Reaction Silicone.

Materials and methods:

It was a prospective comparative in vitro study. This study was carried out in the Department of Prosthodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University. Total duration of the study was from July 2008 to June 2010. Impression of a standard stainless steel die was used as a sample of the study. Sixty impressions of the standard stainless steel die were made by Addition Reaction Silicone and Alginate impression material.

Group-A: Thirty impressions were made from stainless steel die using Addition Reaction Silicone impression material.

Group - B: Thirty impressions were made from stainless steel die using Alginate impression material.

STUDY PROCEDURE:

Laboratory Procedure:

Preparation of the round stainless steel test block: In order to measure Dimensional Accuracy and Surface Detail Reproduction a round stainless steel die was constructed. The die had three parts namely, round stainless steel test block, stainless steel ring and a perforated stainless steel tray. The surface of test block had three horizontal lines in between the vertical lines. The length of the horizontal line in between the vertical line is 20mm and width is 0.4mm and the distance between the top and bottom horizontal line is 4mm. Each horizontal line divided into two halves by pointed punch at the middle of the line. Horizontal and vertical grooves were made on the specimen as reference marks (ab & cd). The stainless steel ring was used to fit around the borders as a mould for the impression material. The perforated stainless steel tray was used to hold the impression material.

Preparation of Alginate impression -material specimen:

Required amount of Alginate powder and water were taken according to the manufacturer's recommendations at room temperature. The measured powder was shifted into premeasured

water that has already been poured into a clean rubber bowl. The plastic spatula which was sufficiently flexible to adapt well to the wall of the mixing bowl was used to mix the powder and water. After maintaining the mixing time, impression material was placed on the ruled surface of the test block after placing the round metal ring. Then the metal tray was placed over it for impression making. The impression was removed after setting and the measurement was taken.

Preparation of Addition Reaction Silicone impression material specimen:

Very high viscosity Addition Reaction Silicone duplicating material (putty consistency) was taken. Base and catalyst was taken according to the manufacturer's recommendation and kneaded with clean finger instead of wearing latex gloves to prevent sulfur contamination from these gloves which inhibits the setting of the silicone impression materials and may produce major distortion. After maintaining the mixing time impression material was placed on the ruled surface of the test block after placing the round metal ring. Then the metal tray was placed over it for impression making. The impression was removed after setting and the measurement was taken.

Study procedure:

In this study, impression was made from a standard stainless steel die for measuring dimensional accuracy and surface detail reproduction. The impression materials were prepared according to manufacturer's instruction at room temperature. Mixing time was maintained carefully. Then it was placed in the marked surface of round test block after placing the round metal ring. The metal tray was placed over the impression. A gradual, constantly increasing pressure was applied to the tray in order to remove excess material till it seats perfectly on the ring. Then 0.5 kg weight was placed over the tray and the impression were separated from the test block after their setting. Then the impression was checked for inclusion criteria in the study. All the sample of impression was tested for horizontal and vertical distance by travelling microscope and measurement of surface details by using stereomicroscope (10x).

Testing effects on dimensional accuracy

Dimensional accuracy was measured by measuring length of the middle horizontal line guarded by the vertical line (20 mm) and the distance between the top and bottom horizontal line (4 mm). Every measurement was taken three times and their average values were placed on the data sheet. Measurements were taken by using a traveling microscope (sensitivity 0.01 mm) was used.

Testing effect on surface detail reproduction

The impressions were separated from the test block after setting, and their surfaces was assessed by using a stereomicroscope for reproduction of the lines from the test block surface at a magnification of 10X. Then their photographed was recorded.

The samples were graded as follows ⁹.

Grade.1: Good detail, continuous line.

Grade.2: Poor detail, some discontinuity of the line.

Grade.3: Marginally or not discernable.

Data were collected on the basis of Dimensional Stability and Surface Detail Reproduction according to pre designed data collection sheet (Appendix-I) and collected data was recorded on the pre designed data collection sheet. After coding and editing data were analyzed by SPSS (Statistical Package for Social Science for windows version-12). Chi Square and T-test were done to find out significance value.

Results:

All samples were evaluated under two parameters and those evaluations described in tables. In terms of dimensional accuracy, analysis revealed that Addition Reaction Silicone impression material is dimensionally more accurate than Alginate impression material which is statistically significant. Furthermore; according to surface detail reproduction Addition Reaction Silicone produce better surface details than Alginate impression material which is also statistically significant.

Table I: Distribution of impression of standard stainless steel die (ab=20 mm) according to dimensional accuracy.

Group	Mean±SD	P value
Group A	19.91±0.11	0.001
Group B	19.72±0.18	

Group A = 30 impressions of Addition Reaction Silicone

Group B = 30 impressions of Alginate
ab= Length of the horizontal line in between the vertical line
of stainless steel die.

Table I shows that length of the horizontal line in between the vertical line (ab=20 mm) of Group A mean±SD is 19.91±0.11 mm and Group B mean±SD is 19.72±0.18 mm. Analysis revealed that Addition Reaction Silicone impression material (Group A) is dimensionally more accurate than Alginate impression material (Group B) which is statistically significant between two groups (P<0.05).

Table II: Distribution of impression of standard stainless steel die (cd=4 mm) according to dimensional accuracy.

Group	Mean±SD	P value
Group A	3.81±0.17	0.044
Group B	3.73±0.13	

Group A = 30 impressions of Addition Reaction Silicone

Group B = 30 impressions of Alginate
cd= Distance between top and bottom horizontal line of stainless steel die

Table II shows that cd distance of Group A mean±SD is 3.81±0.17 mm and Group B mean±SD is 3.73±0.13 mm. Analysis revealed that distance between top and bottom horizontal line (cd=4 mm) is dimensionally more accurate in Addition Reaction Silicone impression material (Group A) than Alginate impression material (Group B) which is statistically significant between two groups (P<0.05).

Table III: Comparison of surface details of impression between two groups.

	Group A (n=30)		Group B (n=30)		P value
	No	%	No	%	
Good	28	93.33	20	66.67	0.010
Poor	2	6.67	10	33.33	
Marginally	0	00	0	00	

Group A = 30 impressions of Addition Reaction Silicone

Group B = 30 impressions of Alginate

Table III shows that surface detail of Impression between two groups where group A shows

93.33% good surface detail where as group B shows 66.67% good surface details. Again in group B 33.33% impression shows poor detail while in group A 6.67% poor detail detected. The difference was statistically significant between two groups ($P < 0.05$).

DISCUSSION:

As accuracy and exact reproduction of details is very important for making accurate prosthesis, in this regard choosing a more effective impression material is vital. To select the best impression material several researchers conducted different studies in this area, the present study was also concerned about the same issue.

Current study evaluated the accuracy and reproducibility of impression material to compare the dimensional stability and surface detail change of Alginate and Addition Reaction Silicone impression material.

All impression materials were taken from stainless steel test block for dimensional change and surface detail reproduction. The impression materials, specifically very high viscosity Addition Reaction Silicones (Putty consistency) and Hydrocolloids impression materials, specifically irreversible hydrocolloid (Alginate), were used as impression material in this study.

In terms of dimensional accuracy according to the present study findings addition Reaction Silicone impression material showed better performance than the Alginate.

Because the diameter of horizontal length in between vertical line and top and bottom horizontal line of stainless steel die is more accurate in Addition Reaction Silicone than Alginate. Similar study conducted by ¹⁰ supported the present study results

Where they also considered Addition Reaction Silicone as a better impression material in comparison to Alginate.

Another study ¹¹ found that Addition Reaction Silicone had greatest accuracy as well as good resistant to permanent deformation and considered the most dimensionally stable impression material when compare to Alginate which concur with the result of the present

study.

Regarding Surface Detail Reproduction Group-A representing 93.33% good surface details and 6.67% poor details where as Group-B representing 66.67% good surface details 33.33% poor details. The study showed that Addition Reaction Silicone can produce better surface details than Alginate.

Similarly, ¹² also found in one of his studies, conducted in 2010, where the Addition Reaction Silicone also showed the best performance in terms of overall surface quality and accuracy.

CONCLUSION:

At the end of the study it could be concluded that the Addition Reaction Silicone is a better option for the taking accurate impression, as because it has good surface reproduction capacity and dimensional accuracy.

The study has some limitations: (I) Dimensional stability of Alginate changed within 15 minutes. Measuring through travelling microscope takes more time. It is helpful for us to get rapid measuring tools. (II) Larger sample size can be used. (III) Time dependent dimensional stability can be recorded.

RECOMMENDATION:

Although most of the previous studies including the present study evaluated the Addition Reaction Silicone as a best impression material. In many other studies the performance of Alginate impression material also showed very close result to the Addition Reaction Silicone. Therefore further study could be conducted to overcome the existing confusion and also the limitations of the present study to select the best impression material.

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