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An In-Vitro Study to Compare the Dimensional Stability of Addition Silicone and Polyether Bite Registration Pastes

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Keywords

Dimensional stability
Interocclusal records
Addition silicone
Polyether

Abstract

Introduction: The success of any prosthetic rehabilitating treatment depends on the precise mounting of casts in the articulator. However a major source of error is while taking the registration records and transferring them to the articulator. These errors can be minimized by proper selection of the materials by knowledgeable application of their properties.

Aim: The present study was conducted to find and compare the dimensional stability of polyether and addition silicone bite registration pastes, 1 hour after making of interocclusal record.

Materials and Method: Materials used in the study are polyether bite registration paste (Ramitec 3M) and addition silicone bite registration paste (O – Bite – DMG). A total of 40 specimens (20 specimens from each material) were made which were divided equally into 2 groups. A metal die with two sets of parallel lines in the depression of the die created a square of 1cm in its centre and two points Point A and Point B in the right corners of the square were selected for measurements. The measurements on the die were compared with those of specimens of two groups and %dimensional change of each group was calculated and analysed statistically.

Result: The percentage dimensional change of polyether bite registration paste had a mean of 0.3088cm while addition silicone bite registration paste had a mean of 0.1911cm.

Conclusion: The study concluded that the dimensional stability of addition silicone bite registration pastes was more than polyether bite registration pastes and the results were statistically significant.

1 Introduction

A successful fixed prosthesis depends on the accurate reproduction of the maxillomandibular relationship of the patient in the articulator. This relationship is not simple opening or closing, but a complex relationship which exists in 3 dimensions [1,2]. During the laboratory fabrication of the prosthesis, where restoration is to be coincident with pre-treatment maximum intercuspation, the goal of the interocclusal record is to provide stability and/or support for the casts. Hence this relation should be recorded and transferred to articulator with minimum error.

Ideal requirements of bite registration material [3] are:

- The materials should offer limited resistance before setting to avoid displacing the teeth or mandible during closure, whereas after setting, it should be rigid or resilient, with minimal dimensional change.
- It should be easy to manipulate with no adverse effects on the tissues involved in the recording procedures.
- It should accurately record the incisal and occlusal surfaces of teeth.
- A very important feature - it should be verifiable.

In the era of developing world of dentistry the different materials are introduced for interocclusal record with different brand names [4,5]. Wide variety of interocclusal record materials are available in the market like zinc oxide–eugenol paste, Impression plaster, metalized wax, acrylic resin and the latest being elastomers – addition silicone and polyether. The recording material should exhibit low viscosity initially and not resist the path of mandibular closure. A high viscosity material has the potential to displace periodontally involved teeth and results in mandibular deviation leading to jaw registration inaccuracies [6,7]. The material used should permit passive and positive

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location of the dental casts. Rigid or high surface reproducibility materials may prevent seating of casts easily, often requiring force to articulate the models [8]. The accuracy of the transfer of maxillomandibular relation depends on the dimensional stability of the material and the technique used to record the relationship. Although the errors can be minimized by careful technique and control of materials, it is a known fact that they cannot be completely eliminated because of the inherent properties of the various materials that may be used in the procedure [9]. Investigations have shown that most of the materials continue to undergo dimensional changes even after the setting time indicated by the respective manufacturers [10,11]. Once the record is obtained, it must be carefully handled by the laboratory personnel while using it to mount the models on the articulator.

The objective of the present study was to evaluate and compare the dimensional stability of polyether and addition silicone bite registration pastes, 1 hour after making of interocclusal record.

2 Material and Methods

In the present study, commercially available polyether bite registration paste (Ramitec 3M) and Vinyl polysiloxane (Addition Silicon) bite registration paste (O – Bite – DMG) are used. The evaluation of dimensional stability was done at Department of Physics, MES Engineering College, Kuttippuram using travelling microscope (Fig-1).

Fig-1: Travelling Microscope.

2.1 Fabrication of die

A metal die with upper and lower half was fabricated (Fig-2). Left bottom and top right portion of the lower half of the die was having two holes. Likewise there were two projections on the upper half of the die corresponding to the holes in the lower half which helps in the proper orientation of the die during closure. The lower half of the die was having a circular depression of 2mm depth with 2 sets of parallel lines of uniform depth and size. Two sets of parallel lines in the depression of the die created a square of 1cm in its centre. Two points, point A and point B in the right corners of the square were selected for measurements, which represented the distance between two parallel lines (Fig-3).

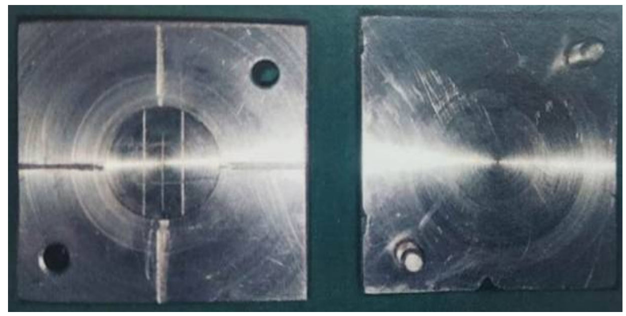


Fig-2: Metallic Die with two parallel lines in lower half.

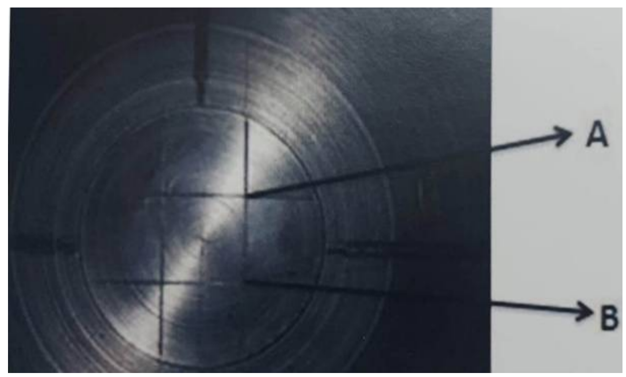


Fig-3: Point A and Point B in metallic die.

2.2 Preparation of test specimens

There were two groups of specimen for comparison of dimensional stability.

A total of 40 specimens were made which were divided equally into 2 groups:

Group 1: 20 specimens made from Polyether Bite Registration Paste (Ramitec).

Group 2: 20 specimens made of Addition Silicone Bite Registration Paste (O Bite).

2.3 Fabrication of test specimen

The test specimen was fabricated using the metallic die. For polyether bite registration paste, required amount of equal length of base and catalyst pastes were dispensed on the mixing pad and mixed using stainless steel mixing spatula to get a homogenous streak free mix according to manufacturer's instruction. For addition silicone bite registration paste, a cartridge of the registration paste was fixed to the auto mixing gun with spiral mixing tip and mixed according to manufacturer's instruction. The mixed registration paste were loaded to the lower half of the die and then compressed with the upper half of the die, so that the excess material was squeezed out. After the manufacturer's recommended setting time was completed, the die was opened and excess material in the specimen was removed using Bard Parker blade (Fig-4). The circular specimens with correctly replicated 2 sets of parallel lines without air bubbles were selected for the study (Fig-5). The specimens were stored in a dry sealed container for 1hr and then tested. Total of 20 specimens from each group were selected for the measuring dimensional stability.

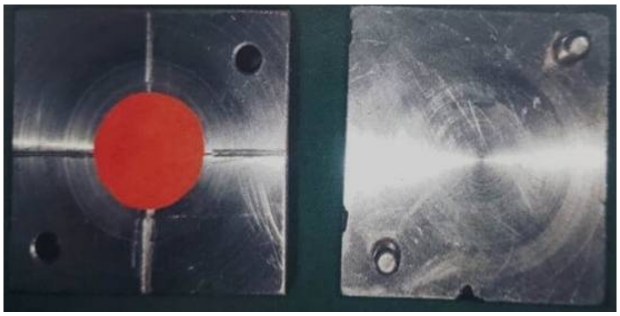


Fig-4: Fabrication of test specimen.

Fig-5: Test specimen for measurement.

2.4 Procedure

For measuring dimensional stability, lower half of the metal die was taken. It was then placed inside the wooden box of the microscope under the glass to position it correctly under the objective of microscope and the die was focused correctly by looking through the eyepiece and moving the objective of the lens (Fig-6). The holes in the left bottom and top right position of the lower half of the die served as guide in proper placement under the microscope. For the eyepiece, 10x Ramsden eyepiece with fine cross wire lens were used in the microscope. The crosswire in the lens of the microscope should coincide with the lines in the die. First the objective of the lens was focused at the point A. Mean scale reading and vernier scale reading of the point A was found and both the readings were summed up to get the value of that particular point A (Fig-7). Next the objective of the lens is focused at point B; the value for that point B was calculated in the same manner as above using travelling microscope. The difference between value of point B and point A on the metal die was then calculated. The value thus obtained from the die was the standard value which was to be compared with the polyether and addition silicone specimens for evaluating and comparing dimensional stability.

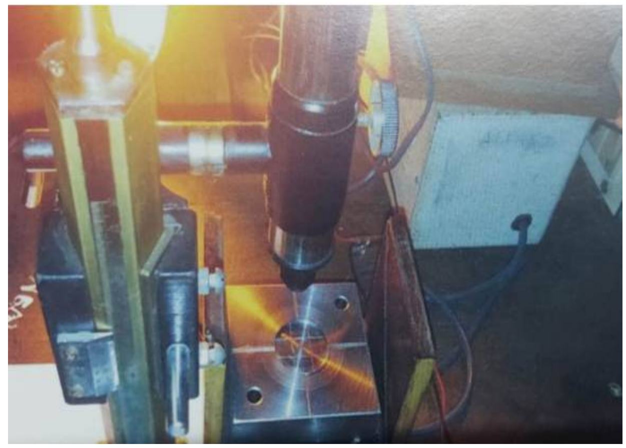


Fig-6: Measuring of distance by travelling microscope.

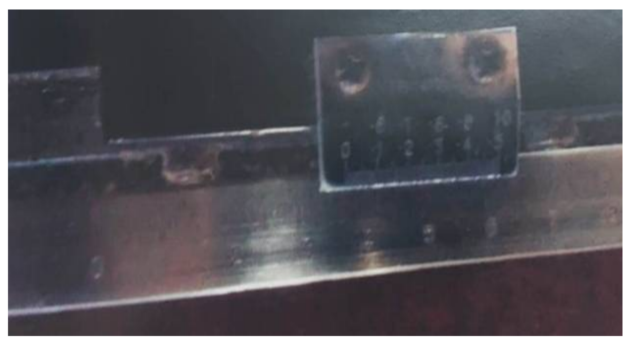


Fig-7: Mean scale and vernier caliper scale readings in travelling microscope.

2.5 Testing the specimens

After 1hr of making, each specimen was taken from the dry sealed container and placed on the wooden box of the microscope under the glass to position it correctly under the objective of the microscope. The specimen was focused correctly by looking through the eyepiece and moving the objective of the lens. The distance between point B and point A is measured for each specimen using the same procedure as described in measuring the distance in the metal die. This distance was compared with distance in the die. The same method was used for all the specimens. The distance between point B and point A in polyether were named Y_1 and addition silicone specimens were named Y_2. After measuring the distance between point B and point A for all the specimens, the percentage change was calculated for each specimen.

The percentage change for Group 1 specimen (polyether bite registration paste – Ramitec) was calculated by the following formula:

$$\textbf{Dimensional Change \%} = \frac{(X-Y1)}{X} \times 100 \quad (1)$$

X – Distance between point B and point A in the metal die

Y_1 – Distance between point B and point A in polyether specimen

The percentage change for Group 2 specimen (addition silicone bite registration paste – O Bite) was calculated by the following formula:

$$\textbf{Dimensional Change \%} = \frac{(X-Y2)}{X} \times 100 \quad (2)$$

X – Distance between point B and point A in the metal die

Y_2 – Distance between point B and point A in addition silicone specimen

2.6 Statistical Analysis

Statistical analysis was performed using SPSS software 19.0 (IBM SPSS Inc., New York, NY, USA). The differences in the dimensional stability of the materials were compared using student's t-test. A *p*-value < 0.05 was considered statistically significant.

3 Results and Discussion

The distance between the two parallel lines on metallic die X was measured using travelling microscope as 1.020cm (Table 1).

Twenty specimens of addition silicone and polyether bite registration pastes were made using this die on which these lines were replicated. After one hour, distance between point B and point A on the specimens Y_1 and Y_2 was measured using travelling microscope and compared with the distance on die (Table 2 and 3).

The percentage change for Group 1 specimen (polyether bite registration paste – Ramitec) and Group 2 specimen (addition silicone bite registration paste – O Bite) were calculated using the formula and tabulated (Fig-8, Fig-9, Table 4 and Table 5).

The percentage dimensional change of polyether was more when compared addition silicone (Fig-10 and Table 6) and the difference were statistically significant as the *p*-value is 0.000 (*p*-value < 0.05) (Table 7).

Table 1: Distance between point B and point A on the metal die measured using travelling microscope.

S. No	Point A			Point B			X = Difference between point B and point A
	MSR	VSR	Total	MSR	VSR	Total	
1	5.35	0.028	5.378	6.35	0.048	6.398	1.020

Table 2: Distance between point B and point A (Y_1) on polyether bite registration paste specimen measured using travelling microscope.

S. No	Point A			Point B			Y_1 = Difference between point B and point A
	MSR	VSR	Total	MSR	VSR	Total	
1	5.35	0.020	5.371	6.35	0.036	6.386	1.016
2	5.35	0.021	5.371	6.35	0.038	6.388	1.017
3	5.35	0.022	5.372	6.35	0.038	6.388	1.016
4	5.35	0.020	5.370	6.35	0.038	6.388	1.018
5	5.35	0.023	5.373	6.35	0.040	6.39	1.017
6	5.35	0.021	5.371	6.35	0.037	6.387	1.018
7	5.35	0.022	5.372	6.35	0.039	6.389	1.017
8	5.35	0.024	5.374	6.35	0.041	6.391	1.017
9	5.35	0.023	5.373	6.35	0.041	6.391	1.018
10	5.35	0.023	5.373	6.35	0.039	6.389	1.016
11	5.35	0.020	5.370	6.35	0.037	6.387	1.017
12	5.35	0.022	5.372	6.35	0.038	6.388	1.016
13	5.35	0.024	5.374	6.35	0.041	6.391	1.017
14	5.35	0.023	5.373	6.35	0.040	6.39	1.017
15	5.35	0.025	5.375	6.35	0.043	6.393	1.018
16	5.35	0.024	5.370	6.35	0.040	6.39	1.016
17	5.35	0.022	5.372	6.35	0.039	6.389	1.017
18	5.35	0.024	5.374	6.35	0.042	6.392	1.018
19	5.35	0.025	5.375	6.35	0.042	6.392	1.017
20	5.35	0.023	5.373	6.35	0.039	6.389	1.016

Table 3: Distance between point B and point A (Y_2) on addition silicone bite registration paste specimen measured using travelling microscope.

S. No	Point A			Point B			Y_2 = Difference between point B and point A
	MSR	VSR	Total	MSR	VSR	Total	
1	5.35	0.025	5.375	6.35	0.043	6.393	1.018
2	5.35	0.027	5.377	6.35	0.046	6.396	1.019
3	5.35	0.026	5.376	6.35	0.044	6.394	1.018
4	5.35	0.024	5.374	6.35	0.041	6.391`	1.017
5	5.35	0.026	5.376	6.35	0.044	6.394	1.018
6	5.35	0.023	5.373	6.35	0.041	6.391	1.018
7	5.35	0.022	5.372	6.35	0.041	6.391	1.019
8	5.35	0.028	5.378	6.35	0.046	6.396	1.018
9	5.35	0.025	5.375	6.35	0.042	6.392	1.017
10	5.35	0.023	5.373	6.35	0.042	6.392	1.019
11	5.35	0.027	5.377	6.35	0.045	6.395	1.018
12	5.35	0.022	5.372	6.35	0.039	6.389	1.017
13	5.35	0.026	5.376	6.35	0.044	6.394	1.018
14	5.35	0.027	5.377	6.35	0.046	6.396	1.019
15	5.35	0.028	5.378	6.35	0.046	6.396	1.018
16	5.35	0.027	5.377	6.35	0.046	6.396	1.019
17	5.35	0.026	5.376	6.35	0.043	6.393	1.017
18	5.35	0.023	5.373	6.35	0.041	6.391	1.018
19	5.35	0.025	5.375	6.35	0.044	6.394	1.019
20	5.35	0.0234	5.374	6.35	0.041	6.391	1.017

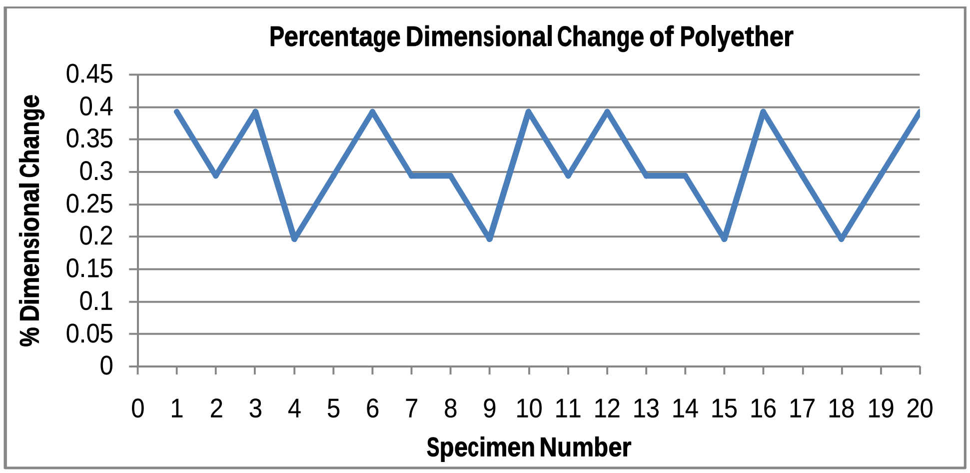


Fig-8: Percentage dimensional change of polyether specimens.

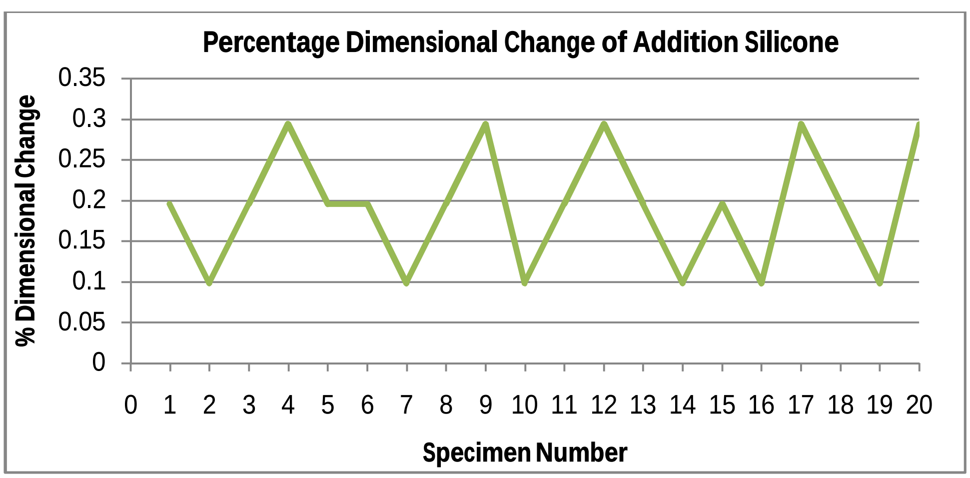


Fig-9: Percentage dimensional change of addition silicone specimens.

Table 4: Percentage dimensional change of polyether bite registration paste.

S. No.	Dimensional Change % = $\frac{(X-Y1)}{X}$ x 100	Mean Value
1	0.3922	0.3088
2	0.2941	
3	0.3922	
4	0.1960	
5	0.2941	
6	0.3922	
7	0.2941	
8	0.2941	
9	0.1960	
10	0.3922	
11	0.2941	
12	0.3922	
13	0.2941	
14	0.2941	
15	0.1960	
16	0.3922	
17	0.2941	
18	0.1960	
19	0.2941	
20	0.3922	

Table 5: Percentage dimensional change of addition silicone bite registration paste.

S. No.	Dimensional Change % = $\frac{(X-Y2)}{X}$ x 100	Mean Value
1	0.1960	0.1911
2	0.0980	
3	0.1960	
4	0.2941	
5	0.1960	
6	0.1960	
7	0.0980	
8	0.1960	
9	0.2941	
10	0.0980	
11	0.1960	
12	0.2941	
13	0.1960	
14	0.0980	
15	0.1960	
16	0.0980	
17	0.2941	
18	0.1960	
19	0.0980	
20	0.2941	

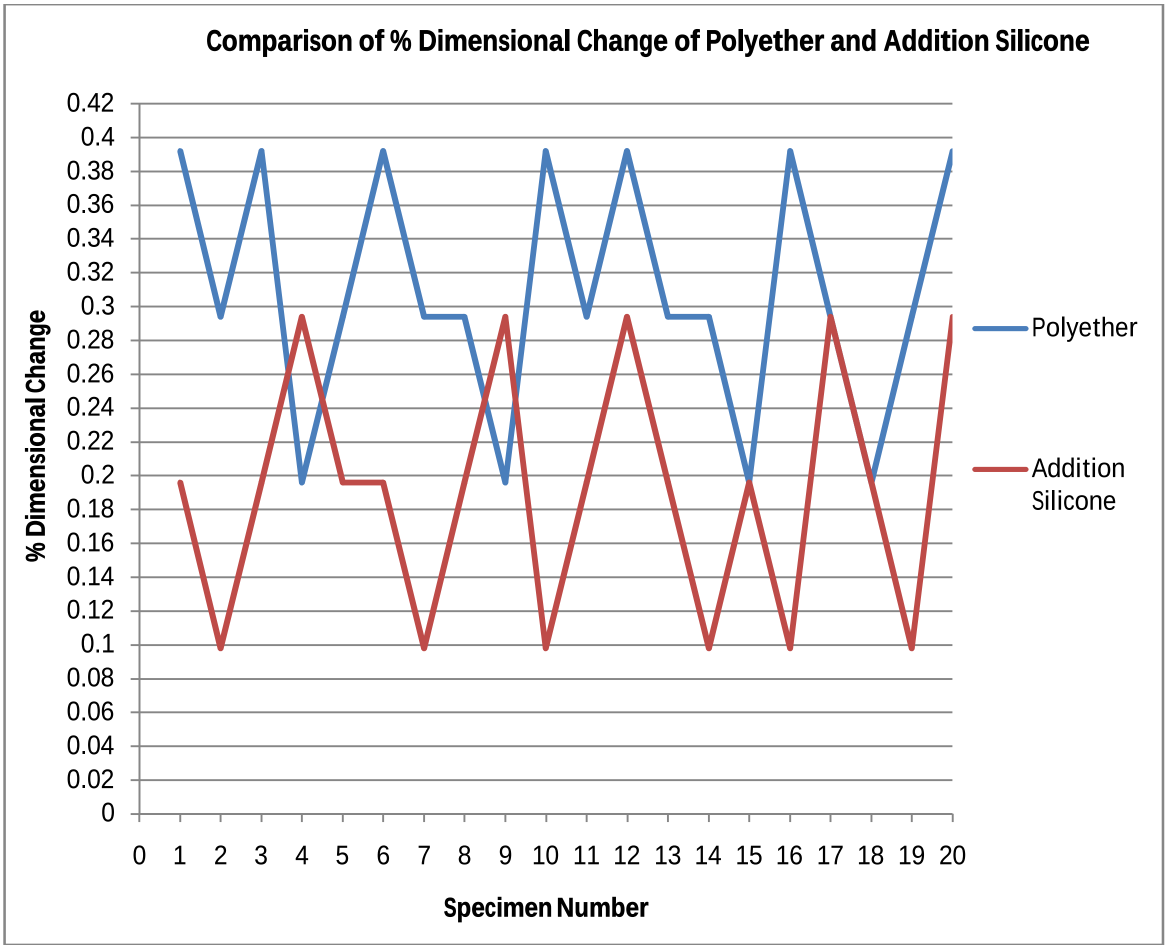
Table 6: Mean and Standard Deviation of polyether and addition silicone bite registration paste.

	Group	N	Mean	Standard Deviation
Percentage Dimensional change	Polyether	20	0.3088	0.07310
	Addition Silicone	20	0.1911	0.07443

Table 7: t-test for equality of means for measuring percentage dimensional change.

	t – test for equality of means		
	t	df	*p*-value
Percentage Dimensional change (equal variances assumed)	-5.045	38	0.000

Fig-9: Percentage dimensional change of addition silicone specimens.



From the above study following results were obtained:

- The distance between point B and point A on the metal die was measured as 1.020cm.
- The distance between point B and point A for polyether registration paste (Y_1) was ranged between 1.016cm and 1.018cm with a mean of 1.017cm.
- The distance between point B and point A polyether and addition silicone bite registration paste (Y_2) ranged between 1.017cm and 1.019cm with a mean of 1.018cm.
- The percentage dimensional change of polyether bite registration paste ranged between 0.01960cm and 0.3922cm with a mean of 0.3088cm.
- The percentage dimensional change of addition silicone bite registration paste ranged between 0.00980cm and 0.2941cm with a mean of 0.1911cm.

The interocclusal registration material records the occlusal relationship between the natural and/or artificial teeth for planning the prosthesis for construction of removable and fixed partial dentures. Interocclusal records are the maxilla mandibular records that are used to transfer interarch relationships from the mouth to an articulator. An accurate interocclusal record minimizes the need for intraoral adjustments during prosthesis insertion. They are essential in providing high-quality restoration and reducing treatment time and cost.

The introduction of different interocclusal recording materials has put clinicians in dilemma that which material should be used in routine clinical practice for precise recording and transferring of accurate existing occlusal records for articulation of patient's diagnostic or working casts in the fabrication of good satisfactory prosthesis.

The present study is conducted to find and compare the dimensional stability of polyether and addition silicone bite registration pastes, 1 hour after making of interocclusal record. The study concluded that the dimensional stability of addition silicone bite registration pastes was more than polyether bite registration pastes and the results were statistically significant. The reason may be difference in polymerisation kinetics of polyether and addition silicone. Addition silicone was dimensionally stabile material as there are no by-products or loss of volatile elements on setting. There is a more abrupt transition between initial and final during the stages of polymerisation of addition silicone than that of polyether. This may be reason for the increase in dimensional change in polyether at early stages. The dimensional distortion of polyether material as a result of water sorption may also have contributed for its decreased dimensional stability. This might also be due to absorption of moisture from atmosphere by hydrophilic polyether and simultaneously more leaching of water soluble plasticiser.

The results obtained are in concurrence with few studies conducted with same materials. Karaaslan *et al.* (2018) explored time-dependent dimensional stability of three different elastomeric impression materials—vinyl polyether silicone, vinyl polysiloxane, and polyether through micro-computerized tomography imaging and reported vinyl polysiloxane to be the most stable impression material in terms of dimensional changes and wettability [12]. Thomas *et al.* (2016) assessed the effect of storage time and temperature on the dimensional stability of polyvinylsiloxane and polyether impression materials at 10°C, 180°C, 350°C, and 450°C for 24, 48, and 72h. Their results indicated that extreme changes in temperature may produce distortion of the impression materials, and therefore the casts should be poured within 24h to prevent distortion. Furthermore, when polyvinylsiloxane and polyether were compared, polyvinylsiloxane seemed to be more stable than polyether in the test conditions [13]. Hamed *et al.* (2016) evaluated and compared the dimensional changes of different elastomeric impression materials after pouring at varied time intervals by using 3D laser scanner and image software program and concluded that polyvinylsiloxane was a dimensionally stable impression material [14]. The alteration in dimensional stability may also be attributed to the incorporation of percentage of modifiers into the material by the manufacturers to improve the setting time and the other properties. The modifiers used in the bite registration materials may be played a role in altered dimensional stability but it is not confirmed. Further studies may be helpful by the chemical analysis of each ingredient of interocclusal recording materials.

The usage of interocclusal records in the most accepted method of transfer of maxillomandibular relations from the mouth to the articulator. Comparative studies of various interocclusal record materials have shown that the selection of the record material play an important role in the accurate transferring procedure of maxilla - mandibular relation to the articulator. If the selected material is dimensionally unstable, it will have its own impact in causing inaccuracy to reproduce the correct maxillomandibular relationship on the articulator.

4 Conclusion

Oral rehabilitation involves a sequence of steps that must be followed in a highly judicious manner. To properly evaluate a patient's occlusion and to build up an artificial dynamic occlusal scheme, it is mandatory that the diagnostic casts and the final casts are placed in an articulator in approximately the same relationship to the temporomandibular joint as it exists in the patient. The ideal material-technique combination for making interocclusal records would allow the placement of indirectly fabricated prostheses in the patient's mouth with no occlusal adjustment and hence play a major role in the success of the rehabilitative procedures in terms of function and esthetics.

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