Original Article

Comparative evaluation of dimensional stability of three types of interocclusal recording materials: An *in vitro* study

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STATEMENT OF PROBLEM: Interocclusal recording materials should have good dimensional stability for precise articulation. **PURPOSE:** The aim of this *in vitro* study was to evaluate and compare the dimensional stability of three types of interocclussal recording materials at various time intervals. **MATERIALS AND METHODS:** The materials used in the study were polyvinylsiloxane (Virtual), zinc oxide eugenol paste (Superbite) and Bite registration wax (Alumax). The test was carried out using a mold of the American Dental Association (ADA) specification No. 19. A total of 30 samples were made with each group consisting of ten samples. The samples were measured using an optical microscope with a micrometer provision. The measurements were made at time intervals of 1, 24, 48 and 72 hrs. **RESULTS:** Five readings were taken for each sample at each time interval and the mean was considered to measure the dimensional change by comparing with that of the original measurement in the die. The results obtained were statistically analyzed using a one-way analysis of variance (ANOVA) and Tukey-(Honestly Significant Differences) HSD test. The mean percentage dimensional change at various time intervals: I) Group A 1 h-0.22%, 24 h-0.48%, 48 h-0.66%, 72 h-0.79%; II) Group B 1 h-0.58%, 24 h-0.93%, 48 h-1.23%, 72 h-1.46% III) Group C 1 h-0.44%, 24 h-0.60%, 48 h-0.77%, 72 h-1.07%, respectively. Group A was dimensionally the most stable of the three groups followed by Group C and then Group B. **CONCLUSION:** Dimensional stability is influenced by both the “material” and “time” factors and is found to decrease as the time factor increased. Polyvinylsiloxane (Virtual, Group A) was dimensionally the most stable followed by zinc oxide eugenol paste (Superbite, Group C) and then Bite registration wax (Alumax, Group B).

Key words: Bite registration material, dimensional stability, interocclusal records

To create a harmonious occlusion, it is essential to record the existing maxillomandibular relationships with the help of interocclusal recording materials. Interocclusal recording materials are basically similar to impression materials but are modified to give good handling characteristics.[1,2]

However, whether these modifications in the parent impression materials result in altered dimensional stability properties is unknown.[1,2]

In the above context, the present *in vitro* study was conducted with the aim of evaluating and comparing the dimensional stability of three types of interocclusal recording materials at time intervals of 1, 24, 48 and 72 h.

MATERIALS AND METHODS

Fabrication of the samples

The materials used in the study were polyvinylsiloxane (Virtual, Ivoclar, USA)-Group A, Bite registration wax (Alumax, Yetti Dental Corp, Germany)-Group B and zinc oxide eugenol paste (Superbite, Bosworth USA)-Group C. The test was carried out using a mold of ADA specification No. 19 [Figure 1]. A total of 30 samples were made with each group consisting of ten samples.

The individual materials were manipulated according to the manufacturer’s instructions. All materials were conditioned at ambient room temperature for at least 24 h prior to testing. Materials that were supplied in automixing cartridges were dispensed through the cartridges and the materials supplied in tubes such as the zinc oxide eugenol bite registration paste were dispensed by taking equal lengths of the base and catalyst pastes. The material was mixed with a spatula on a glass slab to a streak-free consistency as per the manufacture’s instructions.

For the wax, the method was modified by submerging it in a 45°C water bath for five minutes using a 5 ml glass syringe. This done by breaking the wax and putting it in to the syringe before melting.

After homogenous mixing, the materials were carried to the die. The die was inverted on to a 4 x 4 inch square glass plate covered with a polyethylene sheet. Hand pressure was applied for five seconds to initially express the materials, followed by application of a 500 g weight to further remove excess materials.

The mold, the stainless steel die and the weight were submerged in a 36 ± 1°C water bath to simulate oral conditions.

Each assembly remained in the bath for the manufacture's suggested setting time plus an additional three minutes to ensure polymerization of material. Upon removal from the water bath, the mold assembly was removed from the stainless steel die and all the excess material (Flash) was trimmed by using a Bard Parker knife.

Specimens were in the form of a disk measuring 0.3 cm in thickness and 3 cm in diameter with three parallel lines on the surface. These three lines were named A, B and C which are equally separated by a distance of 2.5 mm.

Measurement of the test samples

The distance between the parallel lines A and C was measured using an optical microscope with a micrometer provision [Figure 2]. The magnification used for the measurement was 10X.[3]

The distance between the two parallel reference lines A and C was measured at five fixed points. These reference points were scribed in the metallic die and were copied in the samples during their fabrication.

The mean of the five readings was used for calculation for each sample. Readings were recorded for all ten samples of each group at intervals of 1, 24, 48 and 72 h.

The mean measurement of the distance AC in each sample was compared to the corresponding measurement of 5000.20 micrometer in the standard stainless steel die measured under the same optical microscope.

RESULTS

Statistical analysis was performed using analysis of variance (ANOVA) and Tukey-honestly significantly different (HSD) tests for comparisons among groups at the 0.05 level of significance. The mean percentage dimensional changes for Groups A, B and C at various time intervals are shown in Table 1 and Figure 6.

Group A (polyvinylsiloxane) presented the smallest linear changes of all the materials tested at all time intervals, followed by group C (Zinc oxide eugenol) finally group B (Alumax).

DISCUSSION

Interocclusal recording materials are generally used to record maxillomandibular relationships. These materials should have a good dimensional stability to achieve proper articulation.

The linear dimensional changes of some interocclusal recording materials were measured over time in this study. These measurements provide an indication of the dimensional stability. However, dimensional stability can also be studied in all the three planes using equipments like the condymeter, computerized Axiotron and Buhnergraph.

The above mentioned time intervals were selected based on the time taken to carry interocclusal recording materials to distant laboratories or the delay in the articulation of a cast in the laboratory.

As the present study measures only linear changes, an optical microscope with a micrometer provision was chosen for the measurement as per the testing methodology for ADA specification No. 19.

Several factors contribute to the dimensional changes of the materials used for interocclusal recording. The major factor being the loss of volatile substances over time. Several studies were conducted to find the reason for linear changes by correlating them with weight loss induced by the loss of volatiles. A study conducted by Myerson[4] concluded that there is a correlation between the the volatile loss-induced weight loss and linear changes in interocclusal recording materials. However, studies by Millstein[5] and Michalakis *et al.*[2] showed that there is no correlation between the changes in weight and linear dimensions.

Bite registration wax showed the greatest linear changes of all the materials tested in this study. This was attributed to the greater coefficient of thermal expansion[2,6] and distortion due to stress release.[6-8]

The zinc oxide eugenol paste undergoes setting by a

Table 1: Mean percentage changes between different types of interocclussal recording materials at various time intervals

Groups	Mean ± SD	Significant # subgroups at 5% level	*P* value*
1 h			
A Polyvinyl-siloxane	0.226 ± 0.11	A vs B	$P < 0.05$
B Alumax	0.582 ± 0.082	A vs C	
C Zinc oxide eugenol	0.443 ± 0.064	B vs C	
24 h			
A Polyvinyl-siloxane	0.487 ± 0.061	A vs B	$P < 0.05$
B Alumax	0.939 ± 0.08	A vs C	
C Zinc oxide eugenol	0.609 ± 0.082	B vs C	
48 h			
A Polyvinyl-siloxane	0.67 ± 0.092	A vs B	$P < 0.05$
B Alumax	1.235 ± 0.08	B vs C	
C Zinc oxide eugenol	0.774 ± 0.119	A vs C	
72 Hrs			
A Polyvinyl siloxane	0.791 ± 0.076	A vs B	P < 0.05
B Alumax	1.461 ± 0.099	A vs C	
C Zinc oxide eugenol	1.078 ± 0.084	B vs C	

Figure 1: Stainless steel Die

Figure 2: Optical microscope

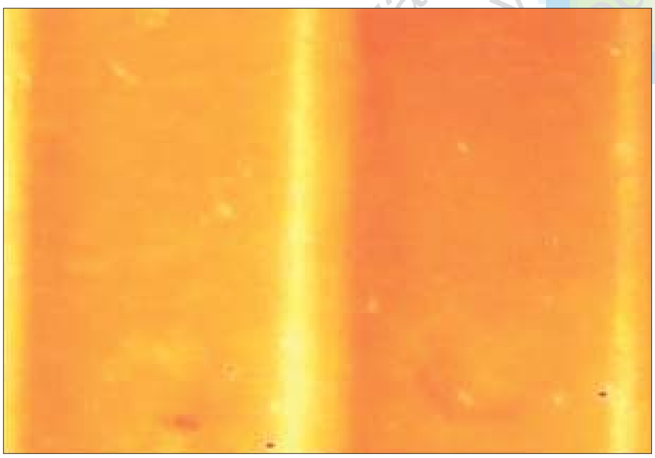

Figure 3: Optical microscopic view of polyvinylsiloxane sample

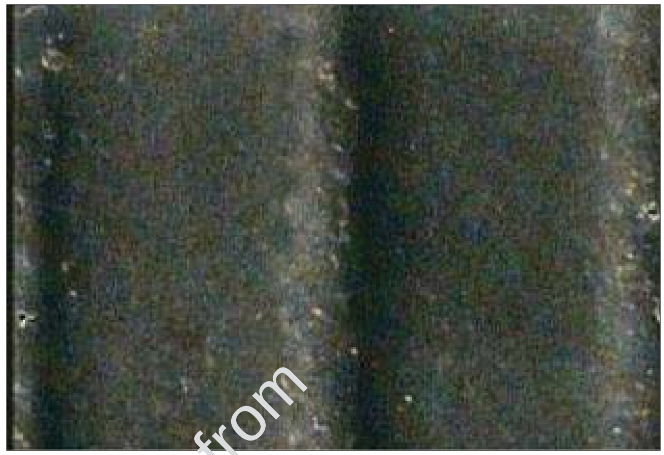

Figure 4: Optical microscopic view of Alumax sample

Figure 5: Optical microscope view of zinc oxide Eugenol sample

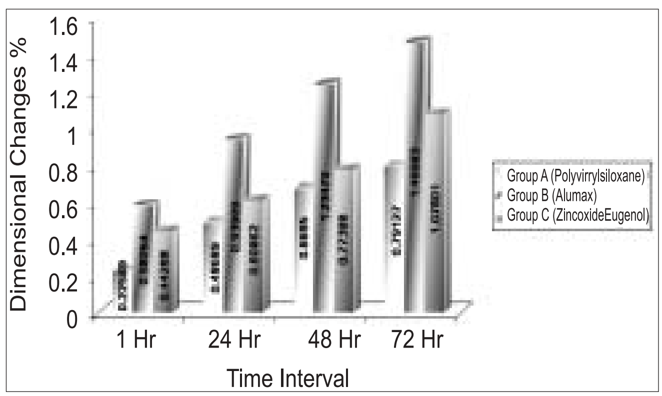

Figure 6: Comparison of dimensional changes at various time intervals for Groups A, B and C

chelation reaction.[6,9] The byproducts of this reaction may undergo evaporation and this may contribute to their dimensional change.[1,2] However, the eugenol free zinc oxide paste used in this study showed less dimensional change when compared to that of the one used in the study conducted by Balthazar Hart *et al.*[1]

The excellent dimensional stability of the polyvinylsiloxane was attributed to the fact that its setting occurred via an addition reaction. Hence, there are no byproducts or loss of volatiles as for the two other materials.[6,9]

Maximum efforts must be taken to fix the indirectly made prostheses, crowns and fixed partial dentures in the mouth without occlusal adjustments. In order to achieve this goal, the use of an interocclusal recording material which is dimensionally stable is of paramount importance.

Several studies have showed that three dimensional changes are induced in an articulator by these materials over time.[7,8,10]

Few authors have suggested ideal times for articulation of casts with respect to the type of interocclusal records used. The study by Muller *et al.*[11] showed that polyvinylsiloxane interocclusal records must be articulated within 24 h and that the zinc oxide eugenol and wax records should be articulated within 1 h to get accurate restoration. The results of this present study are consistent with the above study.

Thus, it becomes mandatory to choose a material depending not only on the clinical situation but also on the time taken for the articulation.

A possible limitation of this study is that it takes only the linear measurement as a parameter for determining dimensional stability as in routine clinical situations, dimensional errors occur in all three dimensions.

CONCLUSIONS

Results were obtained and subjected to statistical analysis from which the following conclusions were drawn:

- Dimensional stability is influenced by both "material" and "time" factors.
- Dimensional stability decreased as the time factor increased.
- Polyvinylsiloxane (Virtual) was dimensionally the most stable material followed by zinc oxide eugenol paste (Superbite) and finally Bite registration wax (Alumax).
- Clinicians must recognize that errors in articulation will be induced by these interocclusal recording materials with the passage of time.
- The ideal time for articulation based on the type of interocclusal records used is < 24 h for polyvinylsiloxane and 1 h for zinc oxide eugenol and wax records.

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