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Comparative Evaluation of Compression Resistance Three Different Interocclusal Recording Materials: An In-Vitro Study

Manju Choudhary

MDS, Prosthodontics, Sikar, Rajasthan

ABSTRACT

Interocclusal recording materials are used to register jaw relationships for mounting dental casts on an articulator. The resistance of these materials to compressive forces is critical, because any deformation during the recording or mounting process would result in, inaccurate articulation of casts and faulty fabrication of restorations. So this in vitro study was conducted
to evaluate the deformation with various thicknesses of three different interocclusal recording materials when subjected to a constant compressive load.

Method: Three commercially available interocclusal recording materials (Momax 2F zinc oxide eugenol impression paste, Polyvinylsiloxane bite registration material and Ramitec polyether bite registration material) were used for the study. Eight specimens of three different heights (2mm, 5mm and 10mm), a total of 24 specimens were made for each interocclusal recording material. Twelve hours after fabrication, each specimen was subjected to a constant compressive force of 25 N for one minute by means of spring testing machine. The deformation of each specimen was measured after 60 seconds of loading to obtain compression distance values.

Results: Significant differences in compression resistance existed between the interocclusal recording materials at each thickness tested. There was a decrease in the compression resistance as the thickness increases among all the interocclusal recording materials.

Conclusion: Polyvinylsiloxane bite registration material exhibited the greatest resistance to compression than the other materials at thicknesses of 2, 5 and 10mm. Therefore the interocclusal recording material should be of minimal thickness and an optimal recording material should exhibit minimal distortion during compression.

Keywords: Interocclusal recording materials, compression resistance, polysiloxane, polyether, zinc oxide eugenol.

INTRODUCTION

An interocclusal record is a precise recording of a maxillomandibular position. [1] Inaccuracies of the cast and the properties of the interocclusal recording material may induce an incorrect placement of the mandibular cast in relation to the maxillary cast on an articulator. [2] Diagnosis and treatment procedures may be inadequate if casts are fixed in a malrelated position. To prevent clinical error, the procedure used to record and fix interocclusal relations should be performed with the utmost care and understanding. [3] Plaster, Modeling compound, Waxes, Acrylic resin and Zinc oxide-eugenol paste are the materials that have been proposed for maxillomandibular registration procedures. [4] The introduction of polyether and polyvinylsiloxane interocclusal recording media has made clinicians unsure which material should be used. These elastomeric materials are chemically similar to the impression materials that have been used successfully for many years. [5] A compressive force is commonly exerted on the interocclusal recording material during the articulation of casts and may cause inaccuracies during mounting of the casts and distortions during fabrication of the restorations. The ability of

an interocclusal recording material to resist compressive forces is critical because of the potential for these inaccuracies. [6]

OBJECTIVES:

The objectives of this study are

1) To evaluate the deformation with various thicknesses of three different interocclusal recording materials when subjected to a constant compressive load.

2) To compare the compression resistance of various thicknesses of three different interocclusal recording materials when subjected to a constant compressive load.

METHODOLOGY

Specimen fabrication: Three commercially available interocclusal recording materials (Momax 2F zinc oxide eugenol impression paste, Virtual polyvinylsiloxane bite registration material and Ramitec polyether bite registration material) were used for the study (Photograph No. 1). Zinc oxide - eugenol impression paste and polyether bite registration material packaged in tubes were hand mixed according to the manufacturer's directions. The polyvinylsiloxane bite registration material available in cartridges was automixed by means of specific syringe tips.

Metallic cylinders: A total of 24 metallic cylinders and 8 metallic bases were standardized for the study (Photograph No. 5). The metallic cylinders were divided into three groups (8 per group) based upon different heights of 10 mm, 13 mm and 18 mm. The metallic bases each of height 8 mm were used for all the groups of metallic cylinders. When the metallic bases were fitted into the cylinders of heights 10 mm, 13 mm and 18 mm, they provided spaces of heights 2 mm, 5mm, and 10 mm respectively in, which the specimens were fabricated.

The walls of the metallic cylinders were lubricated with petroleum jelly before the placement of the materials to facilitate easy removal of the material from the cylinders. Each interocclusal recording material was placed into 10mm (1cm) diameter metallic cylinders of various heights supported by metallic bases at one end and a glass plate at the other end. The materials were then allowed to harden according to the setting time for each interocclusal recording material specified by the manufacturer. Eight specimens were fabricated in three different heights (2mm, 5mm and 10mm), a total of 24 specimens for each interocclusal recording material were made.

Testing of the specimens: Twelve hours after fabrication, each specimen was subjected to a constant compressive force of 25 N by means of the Sushma spring testing machine (Photograph No.7a and 7b). The deformation of each specimen was measured after 60 seconds of loading and compared by means of appropriate statistical analyses.

Figure 1: Interocclusal record materials used in the study

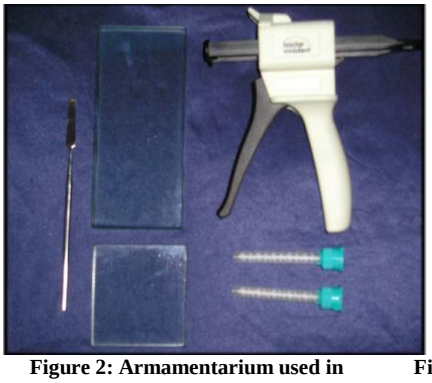

Figure 2: Armamentarium used in

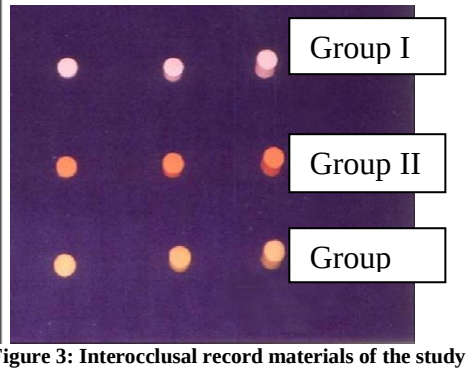

Figure 3: Interocclusal record materials of the study all the three groups

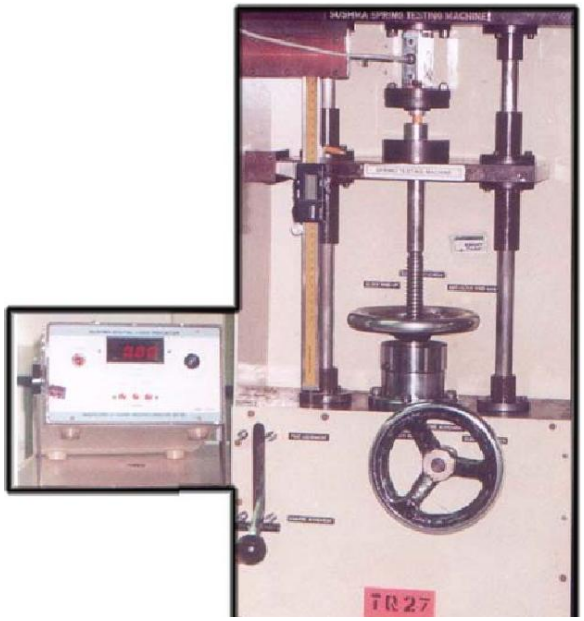

Figure 4: Testing of specimen

RESULTS

The specimens were fabricated in the following manner

Group I : Momax 2F zinc oxide eugenol impression paste was used

I A : Specimens with 2 mm thickness

I B : Specimens with 5 mm thickness

I C : Specimens with 10mm thickness

Group II : Virtual polyvinylsiloxane bite registration material was used

II A : Specimens with 2 mm thickness

II B : Specimens with 5 mm thickness

II C : Specimens with 10mm thickness

Group III : Ramitec polyether bite registration material was used

III A : Specimens with 2 mm thickness

III B : Specimens with 5 mm thickness

III C : Specimens with 10mm thickness

Descriptive data included mean, standard deviation, coefficient of variation and range values were calculated for each of the groups. Comparisons between the groups and within the groups were done by applying one-way ANOVA followed by Student -Newman-Keul's range test. P-value of less than 0.05 was considered for statistical significance.

Table 1 : Master table showing comparison of compression distance values in mm between different interocclusal recording materials of 2 mm thickness specimens. Sub group IA exhibited a mean value of 0.25mm. The difference between subgroups IA and IIA, IIA and IIIA were not statistically significant. The difference between sub group IIA and IIIA was statistically significant.

Table 2 : Master table showing comparison of compression distance values in mm between different interocclusal recording materials of 5 mm thickness specimens.
The difference between subgroups I B and II B, I B and III B were statistically significant. Subgroup II B showed the highest difference from sub group I B. The difference between sub group II B and III B was not statistically significant.

Table 3 : Master table showing comparison of compression distance values in mm between different interocclusal recording materials of 10 mm thickness specimens.
The difference between subgroup I C and II C was statistically significant, but not the

difference between sub group I C and IIIC. The difference between sub group II C and III C was statistically significant.

Table 4 : Shows comparison of compression distance values in mm of group I specimens (Momax 2F zinc oxide eugenol impression paste) at various thicknesses.
The difference between sub groups I A and I B, IA and IC were statistically significant, but not the difference between subgroup IB and I C. Sub group I C showed the highest difference from sub group I A.

Table 5 : Shows comparison of compression distance values in mm of group II specimens (Virtual polyvinylsiloxane bite registration material) at various thicknesses
The difference between sub groups II A and II B, IIA and IIC were statistically significant, but not the difference between subgroup II B and II C. Sub group II C showed the highest difference from sub group II A.

Table 6 : Shows comparison of compression distance values in mm of group III specimens (Ramitec polyether bite registration material) at various thicknesses.
The difference between sub groups III A and III B, IIIA and IIIC were statistically significant, but not the difference between subgroup III B and III C. Sub group III C showed the highest difference from sub group III A.

Table 1 : Master table showing comparison of compression distance values in mm between different interocclusal recording materials of 2mm thickness specimens

Specimen	Zinc oxide eugenol	Polyvinylsiloxane	Polyether
1	0.24	0.18	0.18
2	0.16	0.15	0.20
3	0.13	0.10	0.19
4	0.25	0.11	0.19
5	0.24	0.12	0.18
6	0.13	0.15	0.20
7	0.15	0.13	0.17
8	0.12	0.12	0.22
Mean	0.18	0.13	0.19
S.D	0.06	0.03	0.02
Minimum	0.12	0.10	0.17
Maximum	0.25	0.18	0.22

Table 2 : Master table showing comparison of compression distance values in mm between different interocclusal recording materials of 5mm thickness specimens

Specimen	Zinc oxide eugenol	Polyvinylsiloxane	Polyether
1	0.32	0.21	0.22
2	0.53	0.27	0.26
3	0.30	0.14	0.22
4	0.49	0.18	0.30
5	0.70	0.19	0.32
6	0.27	0.22	0.26
7	0.24	0.20	0.32
8	0.54	0.20	0.31
Mean	0.42	0.20	0.28
S.D	0.16	0.04	0.04
Minimum	0.24	0.14	0.22
Maximum	0.70	0.27	0.32

Table 3 : Master table showing comparison of compression distance values in mm between different interocclusal recording materials of 10mm thickness specimens

Specimen	Zinc oxide eugenol	Polyvinylsiloxane	Polyether
1	0.44	0.32	0.49
2	0.75	0.25	0.35
3	0.61	0.22	0.38
4	0.39	0.32	0.45
5	0.48	0.25	0.53
6	0.54	0.26	0.55
7	0.41	0.42	0.54
8	0.67	0.35	0.44
Mean	0.54	0.30	0.47
S.D	0.13	0.07	0.07
Minimum	0.39	0.22	0.35
Maximum	0.75	0.42	0.55

Table 4 : Showing comparison of compression distance values in mm of Group I specimens (Momax 2F zinc oxide eugenol impression paste) at various thicknesses

Thickness	Mean	S.D	Minimum	Maximum
2mm	0.18	0.06	0.12	0.25
5mm	0.42	0.16	0.24	0.70
10mm	0.54	0.13	0.39	0.75

Table 5 : Showing comparison of compression distance values in mm of Group II specimens (Virtual polyvinylsiloxane bite registration material) at various thicknesses

Thickness	Mean	S.D	Minimum	Maximum
2mm	0.13	0.03	0.10	0.18
5mm	0.20	0.04	0.14	0.27
10mm	0.30	0.07	0.22	0.42

Table 6: Showing comparison of compression distance values in mm of Group III specimens (Ramitec polyether bite registration material) at various thicknesses

Thickness	Mean	S.D	Minimum	Maximum
2mm	0.19	0.02	0.17	0.22
5mm	0.28	0.04	0.22	0.32
10mm	0.47	0.07	0.35	0.55

Formulae used in the study

1) Mean

$$(\overline{X}) = \frac{\Sigma Xi}{N}$$

Where Xi = 1, 2 ……..n

n = Total number of samples studied.

2) Standard deviation

$$(SD) = \sqrt{\frac{\sum (\overline{X}i - X)^2}{n - i}}$$

3) Variance = SD^2

4) One-way ANOVA

$$F = \frac{\text{Between group variance}}{\text{Within group variance}}$$

5) Student –Neuman-Keuls Test,

Minimum significant range,

$$K = K^* \sqrt{\frac{V_e}{N_m}}$$

K* = Table value

V_e = Error variance

N_m = Sample size

DISCUSSION

Direct interocclusal records are most commonly used to record maxillomandibular relationships because of their simplicity. The arches are brought into a relationship with or without tooth contact, and a space is created between the teeth. The recording material, which is initially soft, fills the spaces between teeth, hardens, and records the specific relationship of the arches. The hardened material is then transferred onto casts to be mounted on an articulator. [7] There are various methods of recording maxillomandibular relationships namely, graphic, functional, cephalometric and direct interocclusal. [8] According to Millstein and Hsu, "The interocclusal record should be an accurate and dimensionally stable representation of an interocclusal space that is subsequently transferred to an articulator". [9] The first interocclusal registration was made in 1756 by Philip Pfaff. [4] One of the most desirable characteristics of the interocclusal registration materials is resistance to compression after polymerization. The material should be rigid enough to resist the distortion that might be caused from the weight of the dental casts, the components of the articulator, or other means used to stabilize the casts during the mounting procedure. [10] The ability of an interocclusal registration material to resist compressive forces is very important because any discrepancy between the intraoral relationships of the teeth and the position of the teeth on the mounted working casts will result in restorative errors. [6] Rubber bands are commonly used to sustain the contact of opposing casts during mounting procedures. The maximal force exerted by the use of one standard office supply rubber band (No. 19) to position a maxillary cast to a mandibular cast mounted on an articulator was approximately 25 N, so this value was selected in the investigation. [6] In this study, Virtual polyvinylsiloxane bite registration material showed greater resistance to compression than the other interocclusal recording materials in the 2 mm, 5 mm and 10 mm thickness groups. Studies done by Craig RG and Sun Z, [11] Chai J, Tan E and Pang I C, [12] Campos AA and Nathanson D [13] have also shown that polyvinylsiloxane bite registration material was more accurate and dimensionally stable than polyether bite registration material. Zinc oxide - eugenol paste showed a decrease in compression resistance as the thickness increased when compared to other interocclusal recording materials. The reasons for the decreased compression resistance may be their lengthy setting time, significant brittleness and loss of vital portions of the record through breakage. [13] In all the three groups it has been shown that as the thickness increases, there is increase in the compression distance values. This is in accordance with the studies of Breeding LC, Dixon DL [6] who showed that thicker elastomeric interocclusal registration media are generally more compressible.

SUMMARY AND CONCLUSION

Based on the observations of this study, the following conclusions were drawn

1. All recording materials in this study were compressed clinically significant distances during a constant compressive load.

2. Virtual polyvinylsiloxane bite registration material exhibited the greatest resistance to compression than the other materials at thicknesses of 2, 5 and 10mm.
3. There was a decrease in the compression resistance as the thickness increases among all the interocclusal recording materials.

Therefore if interocclusal recording materials are used to mount working casts, minimal pressure should be exerted on the articulated casts during mounting, the record should be of minimal thickness and an optimal recording material should exhibit minimal distortion during compression.

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