Evaluation of Four Elastomeric Interocclusal Recording Materials

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Abstract

Background: The fabrication of dental prosthesis requires the transfer of interocclusal records from patient's mouth to semi-adjustable articulators using different kinds of recording media. Any inaccuracy in these interocclusal records leads to occlusal errors in the final prosthesis. This study was conducted to evaluate the dimensional changes occurring in the interocclusal recording material over a given period of time and the material's resistance to compression during the cast mounting on the articulator.

Methods: In this in vitro study, the linear dimensional change and compressive resistance of four commercially available elastomeric interocclusal recording media was tested. Three were addition silicones and the fourth was a polyether material. Cylindrical samples of 10mm diameter of each material were prepared in three different thicknesses of 2, 4 and 6mm. Ten samples each of thickness of 2, 4 and 6mm for all four materials were prepared (total of 120 samples). The linear dimensional changes of the samples were evaluated after 24 hours of fabrication. The compressive resistance was measured when each of these was subjected to a constant compressive load of 25 Newtons.

Results: The mean linear dimensional change in a horizontal plane was minimum for Kanibite Hard, an addition silicone. Ramitec showed the maximum linear dimensional change. The mean compression distance was least for Futar D Occlusion (an addition silicone) and maximum for Ramitec (a polyether). It was observed that the samples of thickness 2mm for all the materials underwent least compression.

Conclusion: The compressive resistance of each elastomer was inversely proportional to the thickness of the sample. This implies that minimum thickness of the recording materials should be used for recording maxillomandibular relations without sacrificing the strength of the interocclusal record.

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Key Words: Interocclusal records; Articulation; Occlusion; Linear dimensional change; Compressive resistance

Introduction

The fabrication of an immaculate prosthesis requires that the articulator should simulate the patient's mandibular movements as closely as possible. These articulators require interocclusal records for mounting casts and programming articulators. Any inaccuracy in interocclusal records leads to occlusal errors in the final prosthesis.

Many materials are available for interocclusal registration. These include waxes, metallic pastes, plaster, acrylic resins and elastomeric materials. Adequate laboratory facilities are commonly not available locally and casts have to be sent to other laboratories for articulation. In these situations, the patient's interocclusal records are made and sent along with the cast to the laboratory. This requires that the records must be dimensionally stable for a given period of time before they are used to articulate the casts. A

compressive force is commonly exerted on the recording material during the articulation procedure which may cause inaccuracies during mounting of casts. Each of these interocclusal recording materials exhibits a degree of deformation when compressed under a load. The deformation may vary with the thickness and the properties of the recording materials used. The present study was undertaken to evaluate the linear dimensional change, compressive resistance and effect of varying thickness on the compressive resistance of four elastomeric interocclusal recording materials.

Material and Methods

Four types of interocclusal recording media were used in the study. Three were addition silicones ('Regisil Rigid', 'Futar D Occlusion', 'Kanibite Hard') and one a polyether material ('Ramitec').

A cylindrical brass master cylindrical die was machine tooled for the purpose of this study (Fig.1,2). Three brass

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trays of 10mm internal diameter were machine tooled to fit snugly over the cylindrical master die in the form of hollow cylinders, open at both the ends. When the custom trays were snugly positioned over the die, the difference in the heights of the trays and that of the die varied 2mm, 4mm and 6mm depending upon the height of the tray used. 30 test samples for each of the four materials were fabricated with 10 samples of 2mm, 4mm and 6mm thickness each (Fig. 3). Thus a total of 120 samples were fabricated. These groups were designated as: Group A (Regisil Rigid), Group B (Futar D), Group C (Kanibite Hard) and Group D (Ramitec). The 30 samples of each group were further subdivided into 3 subgroups of 10 samples each. These subgroups were designated as Subgroup I of 2mm thickness, Subgroup II of 4mm thickness and Subgroup III of 6mm thickness.

The samples were stored in tightly sealed containers and kept for 24 hours in an air-conditioned room at 25°C before evaluating the linear dimensional change using a universal measuring machine (Fig. 4). Each of the test samples was loaded on an Instron testing machine (Fig. 5) and subjected to a constant compressive force of 25 Newton for a duration

Fig. 1 :

Fig. 2 :

of one minute. The linear dimensional changes were tabulated and analysed by using one-way ANOVA test. The results were further subjected to a statistical analysis using the two-way analysis and the one-way analysis of variance for compression distances between interocclusal recording materials.

Results

Linear dimensional changes of the samples were tested by measuring the length of line C-D imprinted on the test samples by means of a universal measuring machine. Group C was found to exhibit the least dimensional changes in the horizontal plane (0.10%), followed by Group B (0.19%), Group A (0.22%) and Group D (0.31%) (Tables 1, 2).

The compressive resistance was measured by finding out the compression distance on an Instron Universal Testing Machine, under a constant compressive force of 25 Newton. For each of the thickness, there was significant difference in compression between the four types of materials ($p < 0.001$).

Fig. 3 :

Fig. 4 :

Fig. 5 :

The highest degree of compression resistance for each of the elastomers tested was seen at 2mm thickness. The compression resistance decreased as the thickness increased. "Futar D Occlusion", exhibited significantly higher compressive resistance than other materials (Table 3).

The above results indicate that Kanibite Hard exhibited least linear dimensional change in a horizontal plane and "Futar D Occlusion", exhibited the maximum compressive resistance.

Discussion

The basic objectives for occlusal rehabilitation are optimum oral health, functional efficiency, oral comfort and aesthetics. The interocclusal relationship of mounted dental casts is an accurate representation of the opposing dental arches. The various methods of recording interocclusal relationships are graphic, functional, cephalometric and direct interocclusal recordings. Yurkstas et al [1], analysed various factors influencing centric relation records in edentulous patients and used

wax as a recording medium that was tested for its consistency and variation in degree of softness. Likewise, Wilson et al [2], reviewed different clinical techniques employed for recording retruded contact position. Freilich et al [3], outlined the general principles for selecting interocclusal records. They stated that for opposing casts to be held together in a stable and reproducible manner, both a tripod of vertical support and satisfactory horizontal stability between the two casts are required. Lassila [4], studied the effects of storage and concluded that elastomeric interocclusal recording materials remained dimensionally stable for a long time and moisture caused considerable expansion warranting proper packaging during storage and transfer.

Although no material satisfies all the requirements, a range of physical properties are desirable for ideal recording material [5]. These are low viscosity, low resistance to closure, ease of use, adequate working time, precision in detail, rapid hardening, bio-compatibility and verifiability. Of the various properties enumerated, dimensional stability and the compressive resistance characteristics are not apparent from the previous studies or from the information provided by the manufacturers.

Addition silicone materials showed lesser linear dimensional change in a horizontal plane than the polyether material. Minimum linear dimensional change was observed in Kanibite Hard (0.10%) followed by Futar D Occlusion (0.19%), Regisil Rigid (0.22%) and Ramitec (0.31%). Millstein et al [6,7], developed the 'Hydroptic' system which measured dimensional changes up to 0.025 mm. Lassila et al [4], stated that the contraction, weight loss and the shrinkage in Ramitec interocclusal recording material was found to be greater than the polyether impression material. Shrinkage progressed over the time to reach 0.2 - 0.3% after two hours and 0.3 - 0.5% after 48 hours. Muller et al [8,9], performed a study, which depicted that Ramitec showed greater dimensional changes after storage beyond six hours upto 24 hours of storage. Thus, there was continued shrinkage in first 24 hours.

Table 1

Statistical description of linear dimensional changes (in mm) for each type of group

Group	Observations	Mean linear dimensional change	Standard deviation
A	30	0.0158	0.00024
B	30	0.0138	0.00024
C	30	0.0068	0.00032
D	30	0.0215	0.00026

Table 2

Comparison of linear dimensional changes between different groups of materials by student 't' test at 1% level of significance

Comparison between	Significance
A:B	S
A:C	S
A:D	S
B:C	S
B:D	S
C:D	S

S: significant; P value: $p < 0.001$

Table 3

Two way analysis of variance for compression distance between interocclusal recording material and thickness analysed - by compression distance material thickness

Source of variation	Sum of squares	DF	Mean square	F	Significance of F
Main effects	2.271	5	0.454	117.201	$p < 0.01$
Material	1.7333	3	0.578	149.054	$p < 0.01$
Thickness	0.538	2	0.269	69.422	$p < 0.01$
2-Way interactions material thickness	0.582	6	0.097	25.046	$p < 0.01$
Explained	2.854	11	0.259	66.935	-
Residual	0.419	108	0.004	-	-
Total	3.273	119	0.028		

Dixon et al [10], compared and measured the accuracy of thermoplastic resins, acrylic resins and addition silicone interocclusal recording materials. They used a measuring method developed on a computer axiograph to record positional errors in three planes. The addition silicon group generated significantly less mounting errors than those generated by the acrylic resins and thermoplastic resins. The final test for success or failure of prosthesis is made in the patient's mouth. A demonstration of an excellently planned occlusion on the articulator is meaningless unless that occlusion functions in the mouth in harmony with the biologic factors that regulate the mandibular activity of the patient [11]. The interocclusal relationship of the dental casts mounted on the articulator should be an accurate representation of the opposing dental arches.

Dixon [12], put forward an overview of articulation materials and methods for the prosthodontic patient. He studied various methods for recording the centric relation position and described how the accuracy of recording materials changed over time.

Tripodakis et al [13], carried out a study to determine the accuracy of the fit of interocclusal records on the working casts. The results indicated that the presence of the recording material produced vertical discrepancies on the interocclusal relationships of the casts. Repositioning or transferring of the records enhanced these discrepancies. The proposed modified technique reduced the inaccuracies but did not completely eliminate them. During the mounting process on articulator, compressive forces are exerted on the interocclusal records. Therefore these records should possess adequate rigidity to resist deformation by the casts ("compression resistance"). Excessive forces cause the casts to be placed too close and inadequate forces cause the casts to be mounted too far apart. Researchers have suggested a force of 20- 25 Newton for one minute for evaluating the compressive resistance.

Results of this study showed that compressive resistance of the 2mm thickness samples was significantly higher ($p < 0.01$), followed by 4mm and 6mm thickness samples. This was true for all the four groups. Futar D Occlusion had maximum ($p < 0.001$) compressive resistance and Ramitec minimum. This was attributed to the characteristic "spring" of Ramitec material as observed by Fattore et al [14]. A study by Dixon et al

[10] also showed that the compressive resistance of Ramitec was less than the addition silicones. We found that addition silicones were superior to polyether interocclusal recording media in both parameters.

Conflicts of Interest

None identified

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