(e) ISSN Online: 2321-9599

(p) ISSN Print: 2348-6805

ORIGINAL ARTICLE

Comparative Evaluation of Mechanical Properties of Various Elastomeric Impression Materials

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ABSTRACT:
Background: During making the impression, the material needs to flow and adhere to the tooth structure and periodontal tissues that may be wetted by blood, saliva, and water. Polyether impression materials are composed of moderately low molecular weight polyether, a silica filler and plasticizer and have excellent wettability. Under the light of above evidence, we planned the present study to assess and compare the mechanical properties of various dental impression materials. **Materials & methods:** The present study was conducted in the department of prosthodontics of the dental institution and included assessment and comparison of mechanical strength of various elastomeric dental materials. Elasticity at break (TSb), yield quality (YS), extreme endure break (USb), and resist yield point (Sy) of seventeen monetarily accessible elastomeric impression materials with substantial (HB), medium-(MB), or light-body (LB) textures were assessed in this examination. For every impression material, 10 dumbbell-formed examples were manufactured, as per the outline depicted as sort 1 and sort C, individually. The USb (mm) and the Sy (mm) were recorded. All the results were analysed by SPSS software. **Results: For Acqu- HB and** Flexi- HB study groups, the mean TSb was found to be 5.45 and 5.01 MPa respectively. For Acqu- HB and Flexi- HB study groups, the mean TSb was found to be 2.90 and 2.80 MPa respectively. **Conclusion:** For particular use in prosthodontics dentistry, impression materials should be chosen on the basis of their specific properties.
Key words: Elastomeric, Materials, Tensile.

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This article may be cited as: Pawar MM, Chavan SG. Comparative evaluation of mechanical properties of various elastomeric impression materials. J Adv Med Dent Scie Res 2017;5(9):87-89.

Access this article online	
Quick Response Code	Website: www.jamdsr.com
	DOI: 10.21276/jamdsr.2017.5.9.20

INTRODUCTION

The hydrophilicity of the impression materials is critically crucial to wet the hard and soft-tissues in the mouth and to create accurate impressions and casts.[1] During making the impression, the material needs to flow and adhere to the tooth structure and periodontal tissues that may be wetted by blood, saliva, and water.[2-4] Only when the impression material is hydrophilic, can water be displaced and can the material ideally adhere on these surfaces. Considering the impact of hydrophilicity on accurate die casting, inadequate wetting results in gypsum casts and dies producing pits and voids located in critical areas such as margins, pin holes, and retentive grooves.[5,6] Since, the introduction of polyether in 1969, it has helped clinicians to obtain accurate and dimensionally stable impressions. Polyether impression materials are composed of moderately low molecular weight polyether, a silica filler and plasticizer and have excellent wettability.[7,8]
Under the light of above evidence, we planned the present study to assess and compare the mechanical properties of various dental impression materials.

MATERIALS & METHODS

The present study was conducted in the department of prosthodontics of the dental institution and included assessment and comparison of mechanical strength of various elastomeric dental materials. Elasticity at break (TSb), yield quality (YS), extreme endure break (USb), and resist yield point (Sy) of seventeen monetarily accessible elastomeric impression materials with substantial (HB), medium-(MB), or light-body (LB) textures were assessed in this examination. For every impression material, 10 dumbbell-formed examples were manufactured, as per the outline depicted as sort 1 and sort C, individually. State of dumbbell test examples created by sort 1 of the ISO 37:2005 particulars as well as sort C of ASTM.D412 details. The examples were set up at standard research facility conditions (23°C ± 1°C) by administering impression material from the cartridge into the as of now collected steel form, through horizontal gaps particularly intended for putting the diversely molded cartridge tips. Before infusion, a little measure of material was expelled and disposed of to guarantee legitimate blending in the apportioning tip. A clock was begun promptly after the impression material was first administered into the form. The upper and the lower plates of the split form were kept collected for the entire setting time prescribed by every producer and under a consistent 5 Kg load. After entire setting and form evacuation, any overabundance impression material buildup was painstakingly trimmed away with an extremely sharp edge. Benchmarks were drawn on the example, 12.5 mm on either side of the middle line, therefore setting the test length of the dumbbell examples at 25 mm, as per ISO 37:2005 and ASTM.D412. Example measurements were recorded with an advanced caliper before testing. Three zones of every example limit partition were measured and checked three times to precisely affirm their width and thickness, which were arrived at the midpoint of to acquire a last estimation. Examples that were not as per the measurements determined inside the ISO 37:2005 were disposed of; altogether new examples were hence arranged. Promptly following planning, the examples were secured into the Instron widespread testing machine, holding them on the two sides by pneumatic braces at the area of the beforehand connected benchmarks. Prior to the test started, the dance was balanced with the goal that the example was neither in pressure nor in strain. The examples were stacked in pressure until the point that disappointment with a crosshead speed of 250 mm/minute. The yield point was characterized by the 0.2% balanced strategy, by assessing a 0.2% lasting misshapening as a clinically noteworthy distortion restrict. The USb (mm) and the Sy (mm) were recorded. All the results were analysed by SPSS software. Chi-square test and student t test were used for assessment of level of significance. P- value of less than 0.05 was taken as significant.

RESULTS

For Acqu- HB and Flexi- HB study groups, the mean TSb was found to be 5.45 and 5.01 MPa respectively (**Table 1**).For Acqu- HB and Flexi- HB study groups, the mean TSb was found to be 2.90 and 2.80 MPa respectively (**Table 2**).

Table 1: Mean values recorded for tensile strength at break (TSb) in the different experimental groups.

Study group	TSb (MPa)
Acqu- HB	5.45^{x}
Flexi- HB	$5.01^{x, y}$
Exa- LB	4.20^{z}
Hydro- LB	$2.45^{a, b, c}$

The same superscript letters indicate no statistically significant differences (P > 0.05).

Table 2: Mean values recorded for yield strength (YS) in the different experimental groups.

Study group	YS (MPa)
Acqu- HB	2.90^{x}
Flexi- HB	$2.80^{x, y}$
Exa- LB	2.02^{z}
Hydro- LB	$1.45^{y, z}$

The same superscript letters indicate no statistically significant differences (P > 0.05).

DISCUSSION

In the present study, we observed statistically significant difference in between various study groups in relation to the yield strength.Lawson NC et al compared elastic recovery from tensile strain test with the ISO elastic recovery test for 5 vinyl polysiloxane materials and 1 hybrid material. Specimens (n=5) were fabricated in a brass mold and loaded in tension with a crosshead speed of 300 mm/min to 50% or 100% strains. Two hours following specimen elongation, the change in length of the specimens was measured. Additional specimens (n=5) were tested in tension until failure at 200 mm/min. The maximum elongation at failure was recorded. Elastic recovery specimens (n=4) were prepared for each material following ISO standard 4823. The change in dimension of these specimens was measured following a 30% compressive strain. Group means were compared using 1-way ANOVA and Tukey-Kramer HSD test (alpha=.05). Correlation between different tests was evaluated using Pearson's correlation coefficient. Vinyl polysiloxane materials of varying composition demonstrated significantly different elastic recovery, and the hybrid material demonstrated the least elastic recovery in both tests. All materials exceeded a 100% elongation before failure. Significant linear correlation was found between means of the ISO method and those of a 100% tensile strain (r(2)=0.69, P=.039), but not those of a 50% tensile strain (r(2)=0.56, P=.086). Elastic recovery from compressive strain can only partially predict elastic recovery from tensile strain, suggesting that elastic recovery from tensile strain is a relevant test.[10] Lu H et al compared the mechanical properties, including elastic recovery, strain in compression, tear energy, and tensile strength of 3 hydrophilic impression materials with low and high consistencies were compared. Two addition silicone impression brands (Imprint II, 3M ESPE; Flexitime, HeraeusKulzer) and a polyether brand (Impregum, 3M ESPE) were studied. Two consistencies of each material (light-body and heavy-body) were investigated. Elastic recovery (%) and strain in compression (%) were tested according to ISO 4823; tear energy (J/m2) and tensile strength (MPa) were tested following Webber and Ryge's method and ASTM D412 (Test Method A), respectively. Five specimens were made for each group for a total of 24 groups and 120 specimens. Results were analyzed by 2-way analysis of variance, and Fisher's protected least significance difference intervals were calculated (alpha=.05). Correlation analysis was used to evaluate the relationships among properties. P values were smaller than .0001 for material, consistency, and interaction for strain in compression, tear energy, and tensile strength. For elastic recovery, P values were smaller than .0001 for material and the interaction between material and consistency, but equal to .4150 for consistency. Strain in compression correlated with other mechanical properties (P<.05), but tensile strength and tear resistance were not correlated. In general, new "soft" polyether impression materials had higher strain in compression and lower tensile strength compared to new "hydrophilic" addition silicone materials. Heavy-body materials had higher tear properties and tensile strength than light-body materials. Strain in compression was correlated with elastic recovery, tear energy, and tensile strength. Tear resistance and tensile strength were not correlated.[11] Chai J et al investigated the modulus of elasticity, yield strength, the strain at yield point, and the tear energy of nine elastomeric impression materials. The values of the first three variables were computed from a tensile load test of 10 dumbbell-shaped specimens of each impression material. Tear energy was calculated from the results of a standard trousers tear test on 10 specimens of each impression material. A general descending order of modulus of elasticity (rigidity) follows: poly(vinyl siloxane) putty > polyether >polysulfides and the poly(vinyl siloxane) tray and syringeable materials. The descending order of yield strength was: poly(vinyl siloxane) putty > polyether and most poly(vinyl siloxane) tray and syringeable materials > one poly(vinyl siloxane) and the two polysulfides. The general descending order in strain at yield point (strain tolerance) was: two poly(vinyl siloxane) syringeable materials > four poly(vinyl siloxane) materials of various viscosities > polyether and the two polysulfides. Tear energy followed a general descending order of: polysulfides> polyether >poly(vinyl siloxane). The difficulty of removing impressions made of the putty or the polyether, and the increased risk of die breakage could be associated with the higher rigidity of these materials. The high strain tolerance of the poly(vinyl siloxane) impression materials allows their removal without distortion from appreciable tissue undercuts. The high tear energy of polysulfides indicates their superiority over other impression materials in their resistance to tear in thin sections.[12]

CONCLUSION

From the above results, the authors concluded that for particular use in prosthodontics dentistry, impression materials should be chosen on the basis of their specific properties.

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Source of support: Nil **Conflict of interest:** None declared