INTRODUCTION

Acrylic resins were so well received by the dental profession that by 1946, 98% of all denture bases were constructed from methyl methacrylate polymers or co-polymers. (Craig, 1998) Denture fracture has been one of the most common problems encountered by patients and prosthodontists even after continuous striving to improve their physical, chemical and biocompatible properties. (Grajower and Goultschin, 1984) Fabrication of a new denture is an expensive and time consuming procedure; hence the decision to repair a denture is a convenient and cheaper alternative. Mechanical modifications improve the bond strength by increasing the surface area and mechanical retention. Organic solvents such as ethyl acetate, methylene chloride, chloroform causes etching of the surface of denture base resins and increases mechanical interlocking thereby significantly improving the bond strength between acrylic denture base and the repair resin. (Sarac et al., 2005) Therefore the aim of the study was to evaluate and compare the transverse bond strength of heat cure resin specimens repaired using autopolymerising resin when joint surfaces were mechanically modified with Zigzag and Semi-circular designs and chemically treated using ethyl acetate and chloroform with unrepaired specimens.

MATERIALS AND METHODS

Study was designed and clearances were obtained from department protocol committee and university ethical committee before conducting the study. A Metal mould of stainless steel was fabricated with 8 uniform rectangular shaped spaces (65mm x 40mm x 2mm). Two stainlesssteel
plates of same dimensions were fabricated so as to approximate with the former plate with screw-hole to engage the screws for retention and compression. (Fig.1)

![Fig.1. Stainless steel mold](image1)

**Fig.1. Stainless steel mold**

**Heat cure acrylic resin (DPI Heat cure):** Dental products of India Ltd. Mumbai, India) was manipulated according to manufacturer instructions and was packed in the metal moulds. Specimens were compressed using Sirio hydraulic bench press underer 25psi for 1 hour and then screwed with screws. The curing cycle used for processing of the resin specimens were carried out in a Temperature-controlled water bath at 74°C for 2 hours followed by boiling at 100°C for 1 hour. Bench cooling was done for 1 hour and specimens were retrieved. Specimens were finished, polished according to manufacturer’s instructions and stored for 1 week in water at 37°C. (Fig.2) The sample sizes of 70 specimens were considered for the study.

![Fig.2. Heat polymerized acrylic resin specimen](image2)

**Fig.2. Heat polymerized acrylic resin specimen**

The samples were then cut at the centre horizontally by using carborundum disk (LM abrasives, NB exclusive, Italy), so that the cut surfaces had two different surface modifications such that 30 specimens had a Zigzag design (Fig.3a) at the interface, other 30 specimens had semi-circular design (Fig.3b). Remaining 10 specimens served as control group that were not subjected to any form of repair. One group of 30 specimens were subdivided such that group 1 consisted of first ten specimens immersed in ethyl acetate solution for a period of 1 minute, group 2 consisted of next ten specimens immersed in chloroform solution for a period of 1 minute, group 3 consisted of ten specimens that were left chemically unaltered.

![Fig.3a. Zigzag design](image3a)

**Fig.3a. Zigzag design**

![Fig.3b. Semi-circular design](image3b)

**Fig.3b. Semi-circular design**

The remaining 30 specimens were subdivided similarly. Chemically treated specimen were placed in rectangular metal mould (Fig.4) and gap between fracture line was packed up with auto polymerizing resin (DPI Heat cure: Dental products of India Ltd. Mumbai, India) in dough stage manipulated according to manufacturer instructions and allowed to cure for 1 hour followed by finishing and polishing using. (Fig.5)

![Fig.4. Specimen placed back to mold](image4)

**Assessment of transverse strength**

Transverse strength of the samples were tested by three-point bending test with the help of universal testing machine (Zwick, Materiaprufung 1445, Germany) at a cross head speed of 0.5
Each sample was placed on a clamp; the distance between two clamps was 40 mm. A load was applied centrally to the specimen through 2.5 mm diameter hardened steel rod. All the tests were carried out under uniform atmospheric conditions of 23°C temperature and 50% relative humidity. (Fig.6)

**RESULTS**

The data was statistically analysed using One-Way ANOVA and Scheffe’s Post Hoc test. Table 1 represents minimum, maximum and mean transverse bond strength of heat cure specimen repaired using autopolymerising resin.

Table 1. Minimum, maximum and mean transverse bond strength of heat cure specimen repaired using autopolymerising resin

<table>
<thead>
<tr>
<th>GROUP</th>
<th>CHEMICAL</th>
<th>Number</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zig Zag</td>
<td>ETHYL ACETATE</td>
<td>10</td>
<td>355.970</td>
<td>568.670</td>
<td>462.2800</td>
<td>7.012228</td>
</tr>
<tr>
<td></td>
<td>CHLOROFORM</td>
<td>10</td>
<td>267.850</td>
<td>261.710</td>
<td>266.2550</td>
<td>4.775041</td>
</tr>
<tr>
<td></td>
<td>WITHOUT CHEMICAL</td>
<td>10</td>
<td>256.700</td>
<td>279.000</td>
<td>264.7200</td>
<td>7.317231</td>
</tr>
<tr>
<td>Semi Circular</td>
<td>ETHYL ACETATE</td>
<td>10</td>
<td>260.250</td>
<td>290.570</td>
<td>275.2520</td>
<td>9.649714</td>
</tr>
<tr>
<td></td>
<td>CHLOROFORM</td>
<td>10</td>
<td>202.500</td>
<td>222.180</td>
<td>212.0820</td>
<td>6.023772</td>
</tr>
<tr>
<td></td>
<td>WITHOUT CHEMICAL</td>
<td>10</td>
<td>245.570</td>
<td>259.890</td>
<td>248.3980</td>
<td>4.569984</td>
</tr>
<tr>
<td>Control</td>
<td>CONTROL</td>
<td>10</td>
<td>390.750</td>
<td>422.350</td>
<td>497.1060</td>
<td>9.814076</td>
</tr>
</tbody>
</table>

Table 2. Represents intergroup comparison of transverse bond strength depicting statistical significant difference between Zigzag and Semi-circular design (p<0.001)

<table>
<thead>
<tr>
<th>TRANSVERSE STRENGTH</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1925.750.978</td>
<td>2</td>
<td>962.875.482</td>
<td>51.826</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>898.750.968</td>
<td>67</td>
<td>1340.956.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2823.925.963</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
On comparison, it was observed that the mean bond strength of specimens in group 1 (Zigzag) which were chemically treated in ethyl acetate was found to have highest transverse strength of 361.25N, while minimum bond strength was observed with group 2 (semi-circular) which was not subjected to any chemical treatment (234.398N). Control group exhibited mean bond strength of 407.1N.

Interpretation of Table 3

There is statistically significant difference (p < 0.001) among zigzag group (n=30) and Semi-circular group (n=30); with mean difference 47.173.

DISCUSSION

Fracture of complete denture is an emergency, irrespective of the causative factors. In majority of cases this becomes an emergency requiring prompt attention. The prime requirement of a patient in case of a fractured denture would be its repair. Repair of fractured denture with self-cured acrylic resin has long been popular as the time required for repair is less and is economical as well. (Stanford et al., 1955) Literature states that various materials and techniques have been tried by different researchers for repairing fractured dentures. George and D’Souza (George and D’Souza, 2001) evaluated the transverse strength of denture base material repaired by heat-cured and self-cured methods with and without surface chemical treatment using ethyl acetate. Both heat-cured samples treated with ethyl acetate showed improved repaired strength. The results of this present study correlate partly with the results of above mentioned study. Minami et al. (2005) reported that specimens reinforced with 1.2 mm diameter stainless steel wire and CoCrNi wires significantly improved the flexural strength, whereas titanium wires and woven glass fibres were not effective for reinforcing denture base repair. Berry and
Funk have suggested the use of vitallium denture strengthenwhich reduces or eliminates the incidence of mandibular denture breakage. (Berry and Funk, 1971) Bowman and Manley (1984) have confirmed that the carbon fiber reinforced polymethylmethacrylate material was stronger by an order of magnitude than a conventional denture material. Beyli and von Fraunhofer (1980) reported that butt joint for repair of fractured denture has been found to be inferior to inverse knife edge, round, and lap joint. Yazdanie and Mahmood (1985) investigated the transverse strength of carbon fiber acrylic resin composite and confirmed that it is stronger and stiffer than unfilled acrylic resin. When choosing a repair technique other factors besides strength such as working time and the degree to which dimensional accuracy is maintained must be considered during repair. (Rached et al., 2004) Repairs without polymerised resin can be performed at room temperature, are cost and time effective and easy to manipulate. (Anusavice KJ, Philip’s, 2003) When self-cured resin are used, repair can be accomplished faster because no denture flasking is required. Additionally, the denture accuracy is maintained because during polymerization not enough heat is present to release stress. Heat-cured repairs require denture flasking and may distort the denture by releasing stress during processing. (Peyton and Anthony, 1963; Tewary and Pawashe, 2014; Saritha et al., 2012) Use of Chloroform or methylene chloride as a chemical agent alters the surface morphology by inducing the formation of cracks and pits approximately 2um in size. These changes can increase the mechanical bond strength, due to penetration of the monomer into the pits and cracks. (Sarac et al., 2005)

Limitations of this study

Effect of repair material, surface design and chemical treatment on transverse strength of repaired acrylic denture base, does not simulate the oral conditions, as repaired dentures are exposed to repeated mechanical stresses during mastication. Also the use of a simple rectangular shaped specimen rather than a complex denture design contributes to the limitations of the present study. Therefore further investigations are necessary to evaluate the strength of repair under more closely simulated clinical conditions.

Conclusion

- The transverse strength of Zigzag design chemically treated with ethyl acetate exhibited highest value.

REFERENCES


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