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International Journal of Current Research
Vol. 8, Issue, 12, pp.43128-43132, December, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

INFLUENCE OF DIFFERENT SURFACE DESIGN AND CHEMICAL TREATMENT ON THE TRANSVERSE STRENGTH OF REPAIRED DENTURE BASE BY AUTO POLYMERIZING RESIN– AN IN VITRO STUDY

***Dr. Ankur Prajapati, Dr. Pronob Kumar Sanyal, Dr. Priya Vaswani, Dr. Shivsagar Tewary, Dr. Shubha Joshi and Dr. Karuna Pawashe**

Department of Prosthodontics and Crown & Bridge, School of Dental Sciences, Krishna Institute of Dental Sciences Deemed University, Karad, India

ARTICLE INFO

Article History:
Received 19th September, 2016
Received in revised form
20th October, 2016
Accepted 15th November, 2016
Published online 30th December, 2016

Key words:

Denture fracture,
Zig-zag design,
Semi-circular design,
Auto-polymerising resin,
Denture repair.

ABSTRACT

Statement of Problem: The fracture of complete denture is a common occurrence in the field of prosthodontics. Often if all other criteria are met such as good aesthetics, occlusion, and functionality; denture repair is acceptable. If denture fractures, we would want the joint surface strength to be as good as original.

Purpose: Influence Of different Surface Design and Chemical Treatment On the transverse Strength of Repaired Denture Base by Auto polymerizing resin

Materials and Methods: Seventy specimens of heat-cured acrylic resin of dimension 65 mm × 40 mm × 2 mm were prepared using a special metal plate. Transverse strength of 10 samples was calculated which served as a control group. Transverse strength of two differently designed joined contours treated with chemicals or without chemicals was then compared with control group and also they were compared with each other and result was statistically analysed with one-way analysis of variance (ANOVA) and Post-hoc ANOVA.

Result: Transverse strength of original specimen was higher than that of repaired specimens. Transverse strength of chemically treated specimens (Ethyl acetate) which were repaired with Zigzag design was found to be higher than others.

Conclusion: Methods of surface modification and chemical treatment have significant effect on strength of repaired denture.

Citation: Dr. Ankur Prajapati, Dr. Pronob Kumar Sanyal, Dr. Priyavaswani, Dr. Shivsagar Tewary, Dr. Subha Joshi and Dr. Karuna Pawashe, 2016. "Influence of different surface design and chemical treatment on the transverse strength of repaired denture base by auto polymerizing resin– An in vitro study", *International Journal of Current Research*, 8, (12), 43128-43132.

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 bypatients 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 autopolymersing resin when joint surfaces were mechanically modified with Zigzag and Semi-circulardesigns and chemically treated using ethyl acetate and chloroform with unrepaired specimens.

****Corresponding author: Dr. Ankur Prajapati,***
Department of Prosthodontics and Crown & Bridge, School of Dental Sciences, Krishna Institute of Dental Sciences Deemed University, Karad, India.

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-holeto engage the screws for retention and compression. (Fig.1)

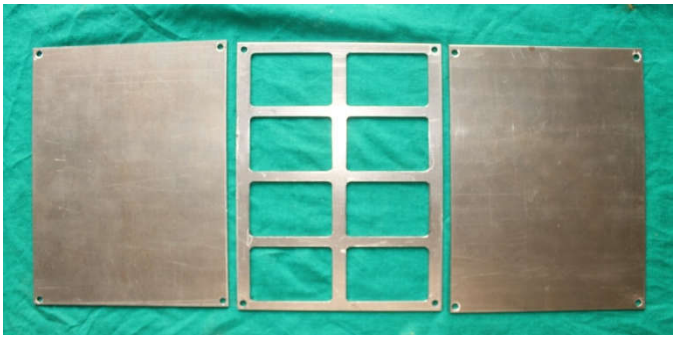


Fig.1. Stainless steel mold

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 pressunder 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 1hour 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.

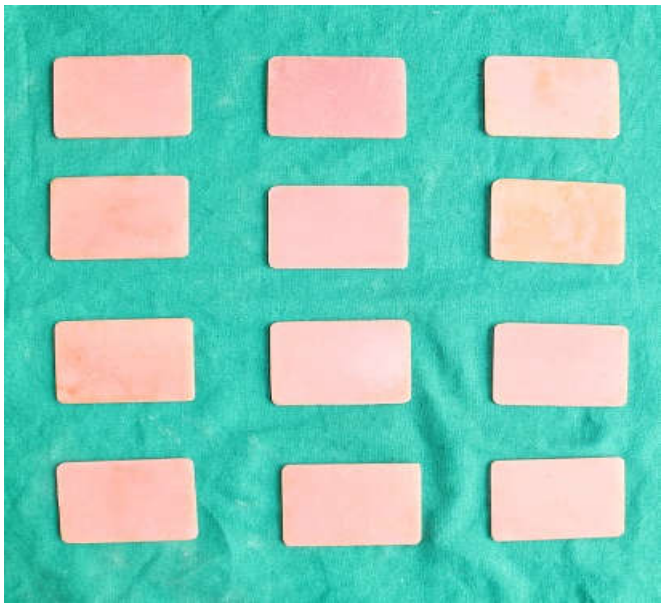


Fig.2. Heat polymerized acrylic resin specimen

The samples were then cut at the centre horizontally by using carborundum disk (LM abrasives, NB exclusive, Italy), so thatthe 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

Fig.3b. Semi-circular design

The remaining30 specimenswere 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)

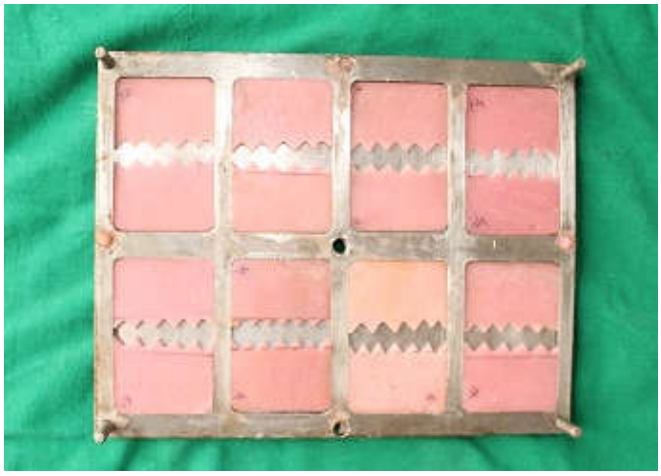


Fig.4. Specimen placed back to mold

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

cm/min. 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)

Fig.5. Gap filled with autopolymerizing resin

Fig.6. Universal testing machine

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 autopolymersing resin.

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

GROUP	CHEMICAL	Number	Minimum	Maximum	Mean	Std. Deviation
ZIG ZAG	ETHYL ACETATE	10	355.870	368.670	**361.25800**	4.012258
	CHLOROFORM	10	247.830	261.710	266.25300	4.575041
	WITHOUT CHEMICAL	10	256.700	279.000	240.72000	7.317231
SEMI CIRCULAR	ETHYL ACETATE	10	260.250	290.570	275.23200	9.649714
	CHLOROFORM	10	205.500	222.190	252.08200	6.025772
	WITHOUT CHEMICAL	10	245.570	259.890	**234.39800**	4.569984
CONTROL	CONTROL	10	390.750	422.350	**407.10600**	9.814076

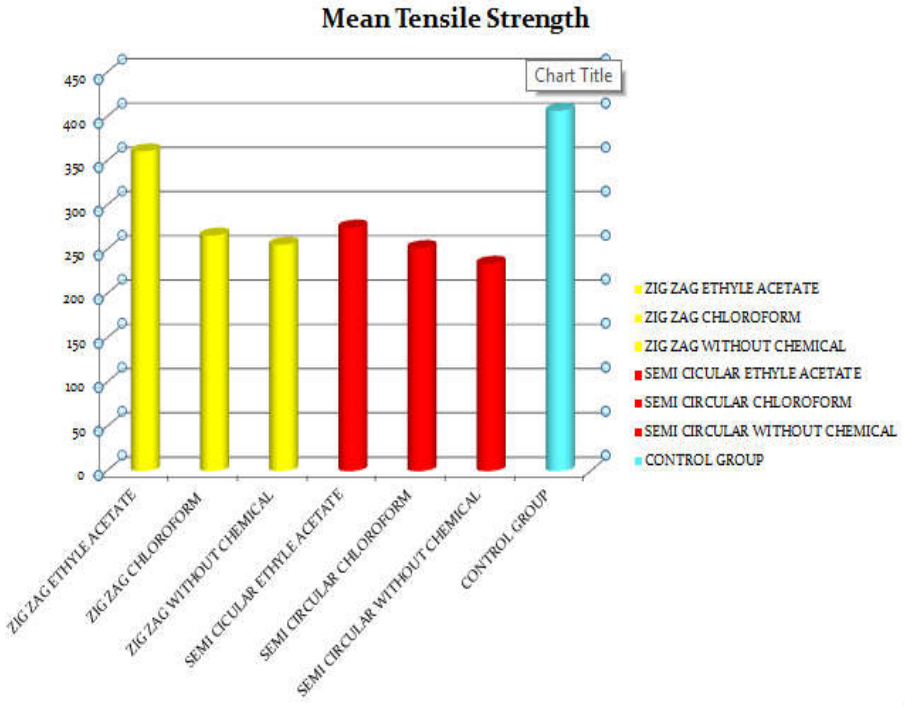
Table 2. Represents intergroup comparison of transverse bond strength depicting statistical significant difference between Zigzag and Semi-circular design (p<0.001)

TRANSVERSE STRENGTH					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	192575.056	2	96287.528	71.826	<0.001*
Within Groups	89817.508	67	1340.560		
Total	282392.563	69			

Table 3. Intra group comparison/Group wise comparison among two groups by post hoc Scheffe's test

Dependent Variable: TRANSVERSE STRENGTH

(I) GROUP	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
ZIG ZAG	47.173000*	9.453605	< 0.001	23.50588	70.84012
SEMI CIRCULAR	-112.695667*	13.369417	< 0.001	-146.16603	-79.22530
CONTROL	-159.868667*	13.369417	< 0.001	-193.33903	-126.39830



Graph 1. Minimum, maximum and mean trasverse bond strength of heat cure specimen repaired using autopolymersing resin

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 materialrepaired by heat‐cured and self‐cured methods with andwithout surface chemical treatment using ethyl acetate. Both heat‐cured samples treated with ethyl acetate showedimproved repaired strength. The results of this present study co-relate partly with the results of above mentioned study. Minami *et al*. (2005) reportedthat specimens reinforced with 1.2 mm diameter stainless steel wire and Co‐Cr‐Ni 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 strengthenerwhich reduces or eliminatesthe incidence of mandibular denture breakage. (Berry and Funk, 1971) Bowman and Manley (1984) have confirmed that the carbon fiber reinforced polymethyl‐methacrylate 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 withauto 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 resins 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 altersthe surface morphology by inducing the formationof cracks and pits approximately 2um in size. Thesechanges 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

- Within the limits of this study, it can be concluded that the method of repair and chemical treatment have significant effect on transverse strength of repaired denture.
- Repair of fractured denture with self-cured acrylic resin has long been popular and can be used as a repair material to increase strength of denture.
- The transverse strength of original specimen was superior to repaired specimen.
- The transverse strength of Zigzag design chemically treated with ethyl acetate exhibited highest value.

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