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EFFECT OF JOINT SURFACE CONTOURS AND CHEMICAL SURFACE TREATMENT ON THE TRANSVERSE BOND STRENGTH OF REPAIRED DENTURE BASE RESIN: AN IN VITRO STUDY

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ABSTRACT

Denture fracture is the most common problem and despite various improvements, the repaired denture often experiences refracture at the repaired site due to poor transverse strength. **Purpose:** The study aims to compare the transverse strength of self cure repair resin using different joint surface contours and chemical surface treatments. **Material and Method:** 60 heat cure resin samples of dimension 65 x 10 x 2.5 mm were cut into 2 equal parts with 45 degree bevel and butt joint and then placed in mould with 3 mm gap in middle for adhering with repair material after surface treatment with isopropanol and ethyl acetate following which they were tested for transverse strength on Universal testing machine. **Result:** The highest bond strength was obtained with autopolymersing resin using bevel joint contour with ethylacetate surface treatment. **Conclusion:** The autopolymerizing resin exhibited significantly higher repair strength with bevel joint contour. The transverse strength of the repaired specimens was increased significantly after chemical treatments.

KEYWORDS: Dental prosthesis repair, isopropanol, ethyl acetate, transverse strength, joint contours.

INTRODUCTION

Acrylic denture base materials are widely and most commonly used in dentistry ever since it was introduced in 1937. Despite its popularity, and advantages like satisfying aesthetic demands and other ideal properties, the material is still prone to fracture because it lacks mechanical strength due to which problems are encountered both by the patient as well as prosthodontists.[1-3] The repair of the fractured prosthesis can be accomplished using acrylic resins like heat polymerized, autopolymerized, or light polymerized acrylic resins. Out of these the repair strength of heat polymerized resin is highest[4] but this material require significant amount of working time and tends to warp the denture.[5-6] Autopolymerising acrylic denture base resin has certain advantages i,e convenient to use, fast polymerization, no warpage.[7] Several techniques and materials have been used to repair fractured dentures. The ultimate goal is to restore the actual strength of the denture and to prevent further fracture. [8]One of the principal factors which can vary the strength of repaired joint is its design.[9]

Accordingly the present study has been designed to evaluate and compare the transverse bond strength of self cure repair resin using different joint surface contours and chemical surface treatments. The null hypothesis of the present study is that there is no effect of joint contour and chemical surface treatment on the bond strength of repair material.

MATERIAL AND METHOD

For fabrication of samples of desired shape and size a rectangular shaped prefabricated glass die with dimension of 65 x 10 x 2.5 mm was used whose dimension was in accordance with ADA specification no. 12. Polyvinyl siloxane putty consistency was used to form the mould. Modelling wax (DPI) was poured into the mould and the wax patterns of desired dimension were made. (Fig.1)

Fig 1: Wax pattern fabrication.

Wax patterns were then invested in type III gypsum product using Hanau flask. Packing and curing was done using short curing cycle. Samples were retrieved, finished and polished. (Fig. 2)

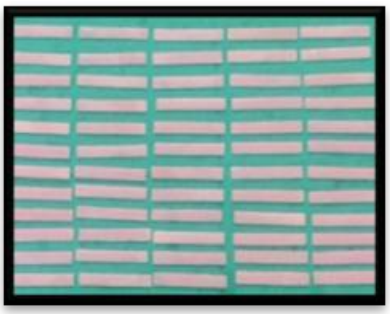

Fig 2: Acrylised samples.

Finished intact specimens were divided into two equal parts, i.e. 31mm each with two different types of joint surface contours and placed in the putty mould of dimension 65 x 10 x 2.5 mm with gap of 3 mm in middle of mould for adhering with the repair material. (Fig .3) Each fractured sample was surface treated according to their respective groups i.e. Group A (No surface pre treatment with 45° bevel joint (Control), Group B (No surface pre treatment with butt joint contour (Control), Group C (Isopropanol surface pre treatment with 45° bevel joint contour), Group D (Isopropanol surface pre treatment with butt joint contour) Group E (Ethyl acetate surface pre treatment with 45° bevel joint contour) and Group F (Ethyl acetate surface pre treatment with butt joint contour) After repair with autopolymerising resin the samples were kept in the pressure pot under pressure of two bars at 37° for 15 min.

Fig 3: Samples after repair.

TESTING OF SAMPLES

Before testing, the specimens were stored in water at room temperature for 1 day. Repaired samples were tested for transverse strength by three point bending test on Instron universal testing machine. The loading jig consisted of two parallel blocks set 20 mm apart. A load was applied centrally to the specimens by a plunger with a blunt spearhead equivalent to a 3 mm diameter rod. Each specimen was fractured at the crosshead speed of 5 mm/min. The transverse strength values of each specimen were calculated with the following formula:

$$S = 3WL/2bd^2,$$

Where S is the transverse strength in (megapascals), W is the fracture load (in newtons), L is the distance between the supports (20 mm), b is the specimen width (10 mm), and d is the specimen thickness (2.5 mm).

RESULTS

The recorded data was compiled. Analysis of variance (ANOVA) was employed for inter group analysis of data (Table 2) and for multiple comparisons, Tukey's post hoc test was applied (Table 3). The results of the present study rejected the null hypothesis that there is no effect of joint surface contour and chemical surface treatment on the bond strength of repair.

Significant difference between control and experimental groups was found ($p < 0.001$) In control groups, Group A (No surface pretreatment with 45° bevel joint) showed higher transverse strength (121.1 ± 17.14 Mpa) when compared with Group B (No surface pretreatment with butt joint) which showed (117.79 ± 13.09 Mpa) respectively. The results also showed that heat polymerized resin have higher transverse strength after chemical surface treatments and its highest with ethyl acetate treatment with bevel joint contour repaired groups.

Table 1: Descriptive statistics of transverse bond strength of repaired denture base resin with different edge profile and chemical surface treatment.

	MEAN	S.D	Std. error	Minimum	Maximum
Group A (No pre-treatment + bevel joint)	121.14	17.14	5.42	83.56	143.32
Group B (No pre-treatment + butt joint)	117.79	13.09	4.14	90.11	135.25
Group C (Isopropanol pre-treatment + bevel)	129.38	3.54	1.12	123.12	134.06
Group D (Isopropanol pre-treatment + butt)	126.83	3.85	1.21	121.0	131.95
Group E	141.44	1.31	0.41	139.2	143.18

(Ethyl acetate + bevel)					
Group F (Ethyl acetate + butt)	135.90	4.50	1.42	129.53	141.0

Table 2: Overall comparative statistics among transverse bond strength of repaired denture base resin with different edge profile and chemical surface treatment using One way Anova F test.

	MEAN	S.D	ANOVA F TEST	p value, Significance
Group A (No pre-treatment + bevel joint)	121.14	17.14	F = 9.188	p <0.001**
Group B (No pre-treatment + butt joint)	117.79	13.09		
Group C (Isopropanol pre-treatment + bevel joint)	129.38	3.54		
Group D (Isopropanol pre-treatment + butt joint)	126.83	3.85		
Group E (Ethyl acetate + bevel joint)	141.44	1.31		
Group F (Ethyl acetate + butt joint)	135.90	4.50		

p >0.05 – not significant *p<0.05 – significant difference **p<0.001 – highly significant difference

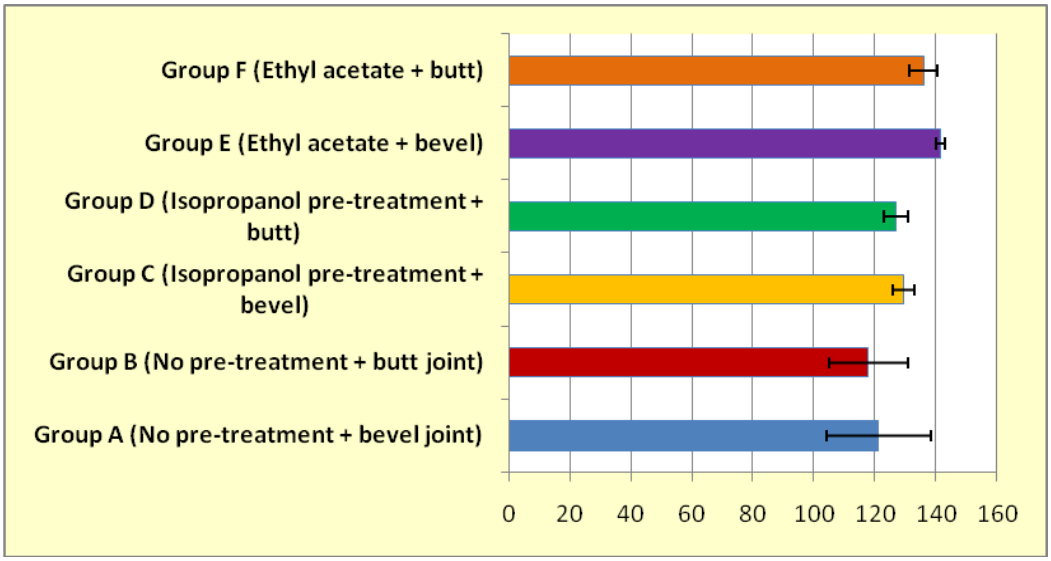

Table 3: Pair wise comparison between among transverse bond strength of repaired denture base resin with different edge profile and chemical surface treatment usingTukey's post – hoc test.

Tukey's post hoc test to find pairwise comparison			
Group	**Comparison Group**	**Mean Difference**	**p value, Significance**
Group A (Bevel joint) Vs	Group B (Butt joint)	3.35	p = 0.965
	Group C (Isopropanol pre-treatment + bevel joint)	8.23	p = 0.363
	Group D (Isopropanol pre-treatment + butt joint)	5.68	p = 0.743
	Group E (Ethyl acetate + bevel joint)	20.29	p <0.001**
	Group F (Ethyl acetate + butt joint)	14.75	p =0.01*
Group B (Butt joint) vs	Group C (Isopropanol pre-treatment + bevel	11.58	p =0.073

	joint)		
	Group D (Isopropanol pre-treatment + butt joint)	9.03	p =0.263
	Group E (Ethyl acetate + bevel joint)	23.64	p < 0.001**
	Group F (Ethyl acetate + butt joint)	18.1	p = 0.001*
Group C (Isopropanol pre-treatment + bevel joint)vs	Group D (Isopropanol pre-treatment + butt joint)	2.55	p = 0.989
	Group E (Ethyl acetate + bevel joint)	12.06	p = 0.056
	Group F (Ethyl acetate + butt joint)	6.52	p = 0.619
Group D (Isopropanol pre-treatment + butt joint) Vs	Group E (Ethyl acetate + bevel joint)	14.61	p = 0.011*
	Group F (Ethyl acetate + butt joint)	9.07	p = 0.259
Group E (Ethyl acetate + bevel joint)vs	Group F (Ethyl acetate + butt joint)	5.54	p = 0.763

p >0.05 – not significant *p<0.05 – significant **p<0.001 – highly significant

DISCUSSION

The results of this study showed that the combined effect of surface designs and chemical surface treatment affected the transverse strength of the repaired acrylic resin base; hence, the null hypothesis was rejected. Significant difference between control and experimental groups was found (P<0.001). The control groups showed significantly lower strength than the experimental groups. In control groups, No surface treatment with 45° bevel joint showed a higher (121.1±17.14 MPa) and with butt joint showed a lower (117.79 ± 13.09MPa) transverse bond strength value.

In the present study transverse bond strength of Group A (No surface treatment with 45° bevel joint followed by repair with autopolymerising resin to heat polymerized acrylic resin was significantly higher than autopolymerising acrylic resin to heat polymerized acrylic resin in Group B (No surface treatment with butt joint contour). This is explained by the fact that the geometry of 45° bevel shifts the interfacial stress pattern more toward a shear stress and away from the more damaging tensile stress during repair. This finding is in accordance with Harrison and Stansbury[10] and Ward, et al.[11] Hanna, et al.[12] also investigated the effect of butt joint and 45° bevel joint on the transverse and impact strength and found higher values with 45° bevel joint. However, surface treatment led to stronger repairs. This is in consistent with the studies done by Lewinstein et al.[13],Vallitu et al.[14], and Nakash et al.[15]

Repair surface treatment agents used in this study were ethyl acetate and isopropanol. Ethyl acetate is an organic and non-polymerisable solvent with the potential to swell the surface and permit the diffusion of the polymerisable material. Its ability to increase the transverse bond strength can be attributed to enhanced adhesion and infiltration of monomer into pits and cracks.[15]

Isopropanol dissolves a wide range of non-polar compounds. It was preferred because it evaporates quickly and is relatively non-toxic, compared to alternative solvents.[15]

The results showed that heat polymerized resin has the highest repair strength after surface treatment and its highest with 45 bevel joint contour and ethylacetate pre treatment.

CONCLUSION

Within the limitations of the study following conclusions can be drawn:

1. The specimens repaired with autopolymerising resin with 45 bevel joint contour showed significantly higher transverse bond strength than specimens repaired with autopolymerizing acrylic resin with butt joint contour.
2. The transverse bond strength of repair material to denture base resin increased significantly with chemical treatments.
3. Transverse strength of 45 degree bevel design samples repaired after ethyiacetate surface treatment showed higher values of transverse bond strength than control group.

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