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ORIGINAL ARTICLE

Effect of Different Joint Designs on Transverse Strength on Repair of Heat Cured Acrylic Resin

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ABSTRACT

Denture fracture is a crucial issue with dental prosthetics. Using mechanical and chemical modifications in the joint area can cause increasing in the binding strength of fractured denture base surfaces, and it must be as original strength as much as possible. So the aim of this study was to identify the effect of different repair design on the transverse strength of acrylic resin material. Out of 40 specimens of heat cured acrylic resin with dimension (65 mmmm×10 mmmm×2.5 mm) (length, width, and thickness respectively), 8 of them were kept intact and considered as a control group. 32 samples were cut at the middle to create a gap (3 mm) and prepared with different joint designs as butt, round, grooves for wire embedding (0.7 mm), and beveled (each of them have 8 samples). Transverse strength was tested. Result of transverse strength test showed that the highest mean value recorded by wire embedding group which equal to (91715), while the lowest mean value represented by round group which equals to (55.605). Modifications that created to the repair area have a significant effect on transverse strength of repaired specimens.

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1- INTRODUCTION

Conventional acrylic dentures are still considered preferred as a therapeutic option to replace missing teeth, for clinical and economic reasons [1]. Crack formation and fracture of resin bases remain a persistent clinical problem [2]. Denture fracture most occur due to poor mechanical properties like reduced impact strength and fatigue resistance [3]. Many factors such as cost, cosmetic demands, and patient acceptance determine the choice of specific dental prosthesis. A socio-economic groups preferred removable partial denture because of its lower cost and availability, despite removable partial dentures are fabricated with cast-metal, and all acrylic resin materials, the most frequently used in developing countries' is all acrylic resin denture due to its excellent [4]. Repair denture by cost effective techniques as well as materials is crucial for certain population groups who using all acrylic denture, the denture base repair must fulfill the important requirement including sufficient strength, be low cost, easy to perform, match the color with original material, and have no dimensional changes. Repairing procedure attempt to restore the original strength of the denture to reduce or prevent the chance of further fracture in future [5].

2- MATERIALS AND METHODS

1. Resin pattern preparation

Four resin pattern were constructed by 3 D printer with dimensions of (65 mmX 10 mm X 2.5 mm ,2.5 length, width and thickness) respectively, that used to fabricate the acrylic resin specimens [6].

2. Specimens grouping

Forty specimens of heat cure acrylic resin type (Conventional heat polymerized acrylic), then forty pecimens were farther divided into five subgroups of 8 specimens as follow, follow, (control, Butt, Round, beveled, and Wire embedding groups)

Fig (1): 3D printer resin patterns

3. Preparation the Mould

Following the he traditional flasking technique for complete denture, the resin patterns were coated with separating agent before investing in the lower half of the flask then filled it with dental stone that mixed following the manufacturers instruction. The ratio of powder/water was 100g/25ml with vibration to remove the trapped air. To facilitate patterns removal, the stone on the lower half of the flask were cover the patterns to about one half of their depth., Mix putty silicon A and B and apply on the resin pattern (remaining half of pattern after silicon set) then flask was filled completely with stone after position the upper half and coating with separating agent again, allowed the stone to set for about one hour before opening the flask, after that the metal flask was opened to enable patterns removal from the mould with caution to prevent mould fracture. The mould were coated with a separating medium to prepared for packing with acrylic dough as see in (fig.2) [7].

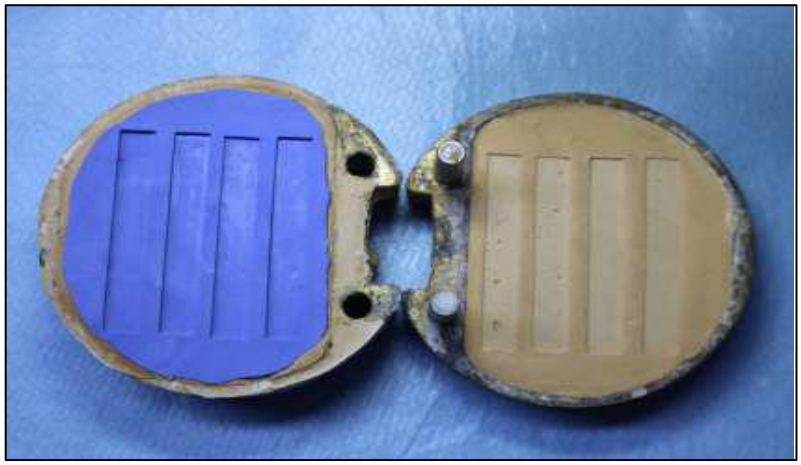


Fig (2): Mould after resin patterns removal

4. Packing and curing of acrylic

After preparation the mould that previously coated with separating media the acrylic packed in dough stage, after mixing according to the manufacturer instruction and reached the dough stage the resin dough removed from the jar and packed into the mould. To insure achieving a metal to metal contact and even flow of the resin throughout the mould space, the flask placed under the hydraulic press, and the pressure was gradually increased, after that the pressure was then released after all flash of material were get out [8]. Water path were used to cure the resin material by placing the flask in a water bath and heated at 74 ºC for 1 ½ hour, then gradually increase the temperature to boiling point (100 ºC) for ½ hour, the curing process were completed. Prevent rapid cooling the flask, the flask was gradually cooled at room temperature for ½ hour, followed by placing the flask under tap water for 15 minute before de-flasking. The specimens were then detached from the mould for finishing [6].

5. Finishing and polishing

The finishing process initiated by acrylic specimens smoothing using an acrylic bur, followed by 120-grit sand-paper under continuous water cooling to prevent overheating of the resin. Then the specimens were polished with a bristle brush and rag wheel using pumice on a dental lathe polishing machine using low speed (1500 rpm) until a shiny surface was accomplished. Final measurements of the specimens were taken using a vernier caliper [7].

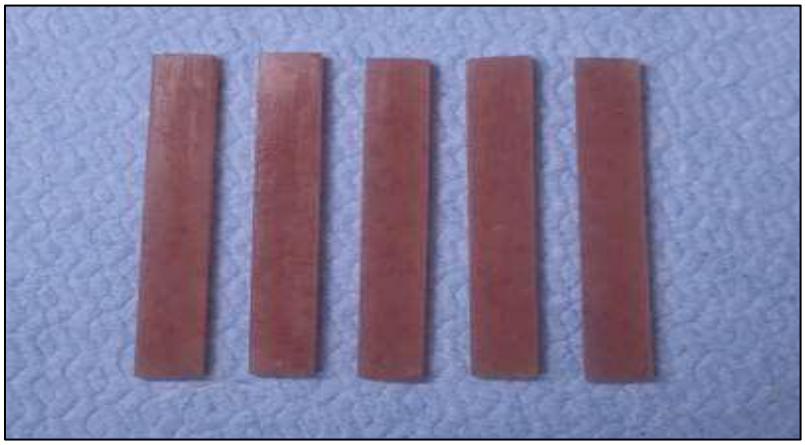
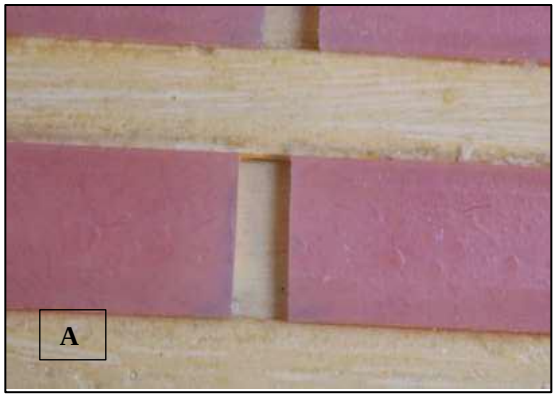
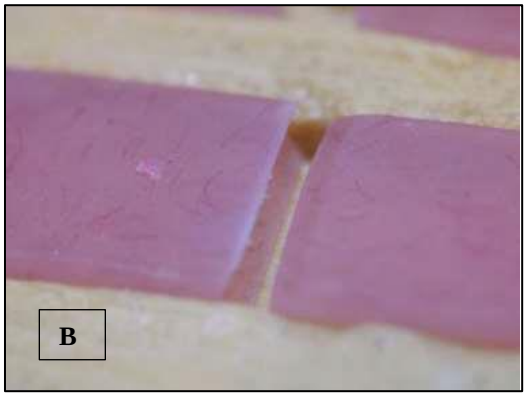


Fig (3): Acrylic specimens

6. Repair process

To accomplish the repair procedure a cut from the middle of 3mm was made for all experimental specimens except control specimens to make a gap for new material [9], the first 8 specimens was left untouched regarded as control .The remaining specimens were repaired as (Butt pattern) (fig 4.A), (Round pattern) (fig 4.B), (wire imbedding group which repaired with wire 0.7 mm in diameter, with zig-zag shape between the gap that created two fractured pieces fig 4.C) .and (beveled pattern) (fig 4.D). To prevent acrylic shrinkage and dimensional change of the specimens all acrylic specimens were kept in distal water after repairing process to be ready for transverse testing using instron testing machine [6].





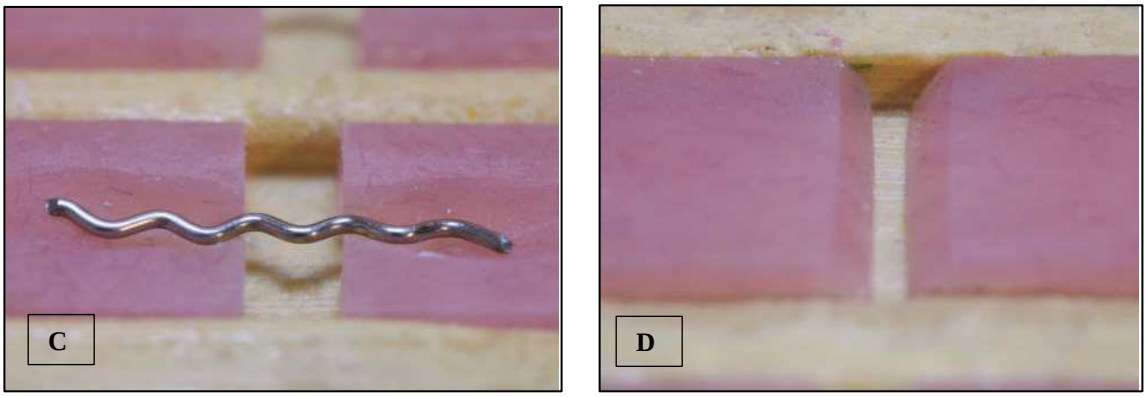


Fig (4): Repair Specimens

3- RESULTS AND DISCUSSION

Results of transverse strength test showed that e among the study groups the highest mean value recorded by wire embedding group which equals to 91715 while the lowest mean value represented by repair with round joint group which equals to 55605 as shown in the table and figure below.

Table (1): Descriptive statistics of transverse strength test

	N	Minimum	Maximum	Mean	SD
control	8	83.70	86.53	85.315	0.95231
wire	8	90.37	93.21	91.715	1.05738
Bevel	8	68.63	71.50	69.808	0.89212
Butt joint	8	57.50	59.63	58.673	0.89399
round	8	53.93	57.37	55.605	1.30664

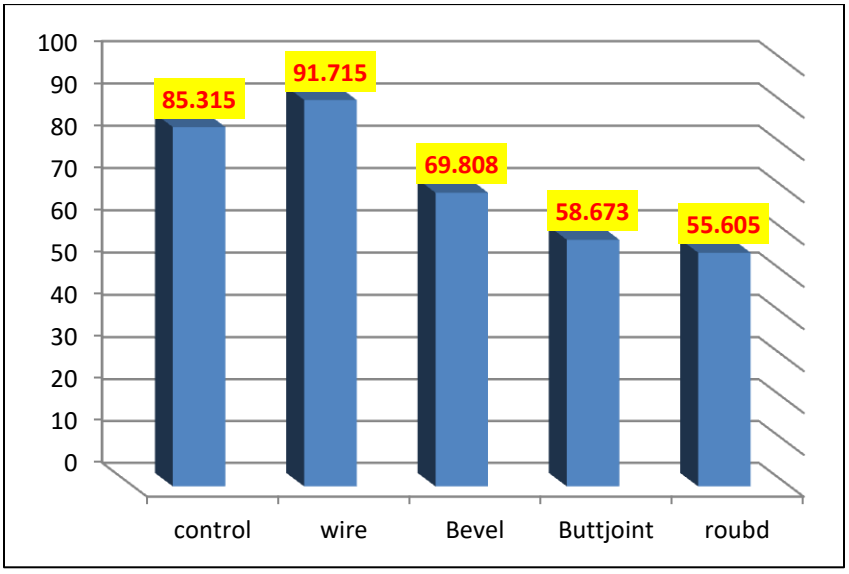


Fig (5): Bar chart of surface roughness test

ANOVA test of transverse strength test revealed that all study groups (P>0.05) were show high significant differences between them.

Table (2): ANOVA test of transverse strength test

	F	P-value	Sig
Between Groups	1908.841	0.000	HS P<0.001

LSD test between each two groups of transverse strength test showed that there were high significant difference among all studying groups except between (butt joint group with round group) in which there was a significant difference, as show in the (Table 3).

Table (3): LSD of transverse strength test

(1) variable	(2) variable	Mean Difference (1-2)	Std. Error	Sig.
Control	wire	-6.40000	.51611	0.006
	Bevel	15.50625	.51611	0.007
	Butt joint	26.64125	.51611	0.000
	round	29.71000	.51611	0.000
Wire	Bevel	21.90625	.51611	0.000
	Butt joint	33.04125	.51611	0.000
	round	36.11000	.51611	0.000
Bevel	Butt joint	11.13500	.51611	0.009
	round	14.20375	.51611	0.008
Butt joint	round	3.06875	.51611	0.045

Special attention is required for complete denture fracture despite of underlining factor, in most cases is an urgent situation that require immediate intervention. [10]. The joining area between the old material and the repair material considered the vulnerable area of the repaired denture bases. To resolve this problem, improving the repair strength by mechanical surface alteration. In the present study repair joint were contoured as used round, right angle or butt, 45° bevel joint designs) as they most incidence in dental clinics. Wire embedding specimens were show a highest transverse strength values than control group, bevel, butt and round joints in sequence. Similar findings were approved that were improvement of transverse strength of denture resin after reinforcement with stainless steel wire [11]. This improvement was attributed to ability of the wire withstand greater force and reinforce the material structure, similar findings were recorded by [12] study also with (9) which indicated a high bond strength of acrylic specimens repaired with a metal wire compared to untreated specimens (control group), this also agree with [13] and disagree with study performed by [14]. The greater contact area between old and new repair material of bevel pattern result in distribution of stresses with butt as well as round joints, in which characterized by sharp-angled surfaces that promote stress concentration, which is directly associated with the magnitude and abruptness of surface variation [15]. Consequently, during the repair of acrylic resin prosthesis, a 45°bevel joint is made to minimize residual stresses which redirect the interfacial stress pattern toward a shear stress and rather than tensile stress, insuring a more uniform distribution and prevent frequent fracture [16].

4- CONCLUSION

Within the limits of this study, from the finding the following conclusions can be drawn:

1-Samples that repaired with wire embedding provided the highest transverse strength among all studying group.

2-The transverse strength of control group was considrably superior to butt joint, bevel and round groups.

3-Round group exhibited lowest transverse strength, then butt joint, and bevel groups respectively.

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