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Impact of Various Joint Designs on the Transverse Strength of Heat-Cured Acrylic Resin Repairs

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Annotation:

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. Once denture fractures, we would want the joint surface strength to be as good as original.

Purpose: The purpose of this study was to determine the effect of different surface design on the transverse strength of repaired acrylic denture resin.

Materials and Methods: Forty specimens of heat-cured acrylic resin of dimension 65 mm× 10 mm× 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 with (3mm) 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 of four joint contours was then compared with control group and also they were compared with each other and result was statistically analyzed with one-way analysis of variance (ANOVA) and LSD. Result: Result of transverse strength test showed that the highest mean value recorded by wire embedding group which equal to (91.715), while the lowest mean value represented by round group which equals to (55.605).

Conclusion: Methods of repair have significant effect on transverse strength of repaired denture. Wire joint design of repair technique was far superior among all studying groups.

Introduction:

Conventional complete denture and partial denture are still preferred as a treatment choice to replace missing teeth, for medical and financial reasons **[carlsson g.e 2010].** Polymethyl methacrylate (PMMA) is frequently used to fabricate complete or partial denture bases because of its numerous advantages, including low cost, biocompatibility, ease of processing, stability in the oral environment, and satisfactory aesthetics **[alla r 2015].** The cracking and fracturing of denture bases is still an unresolved clinical complication in dental practice. It is the primary cause of the failure of the removable prosthesis [takamiya as 2012]. Denture base fracture is primarily attributed to poor mechanical properties like low impact strength and reduced fatigue resistance **[chand p 2011].** The prosthesis may fracture due to impact force during accidental fall or fatigue failure in the course of service. Fatigue failure is caused by the repeated denture flexure from the occlusal force. The progressive resorption of the supporting bone foundation leads to denture instability and movement during mastication. Constant exposure to innumerable stress cycles with improper denture support results in stress accumulation and fatigue failure **[faot f 2008].** The maxillary denture is mostly fractured in the midline running through labial frenulum due to tensile stress from the masticatory forces **[prombonas ae 2006].** Successful prosthetic rehabilitation depends on the diligent balance of static and dynamic forces generated from soft and hard tissues around the denture border. Managing the forces in oral physiology by careful consideration of teeth volume, angulation, volume, neutral zone, and residual ridge morphology is vital for long-term success of denture prosthesis. **[frascaria m 2019,falisi 2017]**

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and all-acrylic materials; the use of all- acrylic removable partial denture prosthesis fabrication is frequently

Aims of study:

The aims of this study are to:

1. Evaluate the effect of mechanical surface treatments on the transverse strength of heat cured acrylic resin denture base material,
2. Determine the effect of different repair surface treatment (Butt, Round, wire, bavaled) on the transverse strength of repaired acrylic denture resin.

Statistical Analysis

Processing of data was carried using SPSS package version 24 to get the statistical methods which were used in order to analyze and assess these results are:

1-Descriptive statistics Statistical tables. Arithmetic mean. Standard deviation. Standard error.

Graphical presentation by bar charts.

2- Inferential statistics

The inferential statistics were used in order to accept or reject the statistical hypothesis which includes analysis of variations (ANOVA) test, and least significant difference (LSD) test.

3- Confidence limit was accepted at level 0.05

3.1 Results

Descriptive statistics (number of specimens, mean, standard deviation, standard error, minimum and maximum) of transverse strength results for all the studied groups were shown in table (3-1) and figure (3-1) which show the bar chart.

Results of transverse strength test showed that the highest mean value among the study groups recorded by wire embedding group which equals to (91.715), while the lowest mean value represented by repair with round joint group which equals to (55.605).

Table (3-1): 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
embedding					
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

ANOVA test of transverse strength test showed high significant differences between all study groups (P>0.05).

Table (3-2): ANOVA test of transverse strength test

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

***P<0.001 High significant**

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 3-3).**

Table (3-3): LSD of transverse strength test

		Mean Difference		
(I) variable	**(J) variable**	**(I-J)**	**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

***P<0.001 High significant**

***P<0.05 Significant**

3.2. Discussion

Fracture of complete denture irrespective of causative factor in majority of cases is an emergency, requiring prompt attention. Earliest repair of denture is main requirement of a patient. 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. **(Mahajan, H., etal, 2014)**

One of the important parameters to be considered while repairing the broken denture base is the selection of an appropriate material which depends on the working time and the strength to be obtained with the repair material. Although literature reveals that various materials such as autopolymerizing acrylic resin, heat-polymerized acrylic resin, visible light-polymerized resin, and microwave polymerized acrylic resin are being used since ages, selection of an appropriate one seems to be challenging. (Mamatha, N.,etal , 2020)

The weakest point of the repaired denture bases is the interface between the heat-polymerized acrylic resin and the repair material. To overcome this drawback, many attempts were made to improve the bond strength by mechanical surface modification. In the present study used butt, round, 45° bevel joints as the repair joint contours due to their prevalence of use in dental clinics. **(Lin, C. T., etal, 2000)** flexural strength values of samples repaired with stainless steel metal wire were higher than control group and samples repaired with bevel, butt and round joints respectively, under same repair conditions. Similar studies were done that showed that the flexural strength of heat-polymerized PMMA denture resin after reinforcement with metal mesh improved. Karthik, etal, 2023)

The transverse strength of repaired acrylic samples was increased after using a stainless steel wire (0.7mm) since the capability of metal wire to resist a higher force and support the materials used for repair. Our results were similar to

Golbidi and Mousavi (2010) study also with Fak **Al-shamari 2014,** which indicated that the acrylic samples repaired with a metal wire displayed a higher bond strength than untreated samples. Control group was followed by bevel, butt, and round joint groups in decreasing transverse strengths, respectively, which was similar to the study done by Sharma and Batra and

contradictory to the study done by Anasane. It could be taken that the greater transverse strength of bevel joint might be due to greater surface area of contact between repair and base material eventually resulting in stress distribution. With both butt and round joints, there were sharp angled surfaces that promote stress concentration, which will be directly related to the degree and abruptness of surface change. **(Mamatha, N.,etal , 2020)**

Therefore, when repairing fractured acrylic resin prosthesis, one should attempt to limit residual stress, by adapting a 45° bevel joint that shifts the interfacial stress pattern more toward a shear stress and away from the more damaging tensile stress, to prevent recurrent structural fracture by distributing these stresses as evenly as possible. **(Winkler S, 2002)**

A clinician's first choice of approach in an event of broken denture would be repair of the existing denture, than opting for a new prosthesis, as the patient would be habituated with function and comfort an old prosthesis delivers. The prevalence of fractured dentures is not uncommon, and when a patient arrives with a broken denture to a clinician, owing to the patient's attitude, the first choice of approach would be repair of the existing denture, provided the occlusal vertical dimension should be satisfactory, the patient's appearance must be acceptable to the patient and dentist, the size, shape, shade, and arrangement of the artificial teeth must be satisfactory, and the oral tissue should be in optimum health. The denture base extensions, interocclusal distance and speech must be satisfactory with the existing teeth arrangement **(Mamatha,N.,etal , 2020)**

4.1. Conclusions

Within the limits of this study, the following conclusions were drawn:

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

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

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

4.2 Suggestion:

Study the effect of other cut design such as rabbit and dovetail on hot and cold cure acrylic resin denture base material.

Study the incorporation of silver nanoparticle and glass fiber to repair the samples.

Evaluate the transverse strength of surface treatment to repair acrylic resin.

valuation the effect of round, and bevel joint designs on other properties such as surface roughness and shear strength.

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