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COMPARATIVE EVALUATION OF FLEXURAL STRENGTH OF SELF CURE AND LIGHT CURE ACRYLIC RESIN USED TO SECURE IMPLANT ATTACHMENT HOUSING TO IMPLANT OVERDENTURES.-AN IN-VITRO STUDY

Dental Science

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ABSTRACT

The purpose of this study is to compare the flexural strength values of four different methods for chair side direct transfer methods of implant housing.

Materials and Methods: Sixty heat-cured polymethylmethacrylate denture blocks were prepared of size 11 (±0.5) x 8 (±0.5) x 38(±0.5) mm. At the centre a hole of 5mmx8mm dimension was made to secure the implant housing.The Implant Housings were embedded in Acrylic Blocks using the four repair techniques Group A:Autopolymerized acrylic resin(APAR)Group B:Light Polymerized acrylic resin(LPAR) Group C:Autopolymerized acrylic resin with sandblasted and silanated attachment housing (APSAR) Group D:Light Polymerized acrylic resin with sandblasted and silanated attachment housing (LPSAR)

The flexural strength of the repaired denture blocks with the attachment housings was measured with three-point bending test using.Statistically analyzed, mean and standard deviation was calculated using ANOVA and Tuckey's test.

Results: revealed that self-cured acrylic with silanated attachment housing yielded the highest mean flexural strength values ($p<0.0001$)

Conclusion: Flexural strength of self-cured acrylic with sandblasted and silanated attachment housing was significantly higher than self-cured, light-cured, and light-cured acrylic with sandblasted and silanated attachment housing groups.

KEYWORDS:

Introduction:

Implant overdentures have become the standard of care for edentulous patients. The success or failure of implants depends on many factors like health of the person receiving it, drugs which affect the chances of osseointegration, The amount of stress that will be put on the implant and fixture and the position and number of implants[1].

A number of overdenture fractures have been demonstrated in areas where copings are present.[2] Because of the increased forces and thinning of acrylic bases brought by accommodation of implant components and tissue bars, failure of overdentures due to fracture is common.[3] Thus, this aspect of denture fracture and repair should be taken into consideration and should be given more focus. Acceptable repair of dentures depends on satisfactory mechanical properties, shear bond strength and adhesion to the fractured parts.[3] Causes of insufficient bond durability may be attributed to contamination of the bond area, thermal stress and cyclic flexural stress during mastication.[4]

Repair of implant overdentures for attachment housing pick-up material does not only entail optimal bonding of the denture base resin and the repair material but also the adhesion between the repair material and the attachment housing.

A variety of materials have been used in dental practice to repair fractured acrylic resin dentures. These include auto-polymerized (self-cured) acrylic and visible light-polymerized (light-cured) acrylic resins.[5] More residual monomer has been observed in self-curing acrylic resins than heat-cured denture base [5] acrylic resins, which acts as a plasticizer thereby affecting the mechanical properties of polymerized resins.[6]Usually, re-fracture of dentures occur at the interface junction of the original base and repair materials[13], thus bond strength produced between the base and repair material is important. mechanical modifications such as grinding with burs, airborne-particle abrasion and laser treatment to increase surface area or chemical pre-treatments of acrylic resins [7] using methyl methacrylate or organic solvents such as acetone, chloroform, methylene chloride may be used. To improve bond strength, mechanical modifications such as grinding with burs, airborne-particle abrasion and laser treatment to increase surface area or chemical pre-treatments of acrylic resins [7] using methyl methacrylate or organic solvents such as acetone, chloroform, methylene chloride may be used. Acceptable repair of dentures depends on satisfactory mechanical properties, shear bond strength and adhesion to the fractured parts.[3] Silanes are commonly used in dentistry, mainly to promote adhesion between dissimilar materials, such as acrylic and metal.[8] To ensure durable retention-free bonding to resins, metals can be coated with a silane adhesive layer using Rocatec (3M ESPE, Minnesota, USA).

The null hypothesis in this study is that there is no difference in the flexural load to failure of acrylic resin blocks after direct transfer of attachment housings using 4 distinct methods:

Group A: Auto polymerised acrylic resin, Group B: Light polymerised acrylic resin,

Group C: Auto polymerised acrylic resin with sandblasted and silanated attachment housings and Group D: Light polymerised acrylic resin using sandblasted and silanated attachment housings.

Materials and Methods:

The study was initiated by making a metal mould of the dimensions 13 x 10 x 41mm. At the centre a hole of 5mmx8mm dimension was made to secure the implant housing.

Sixty heat-cured polymethylmethacrylate denture blocks(FIGURE 1) were prepared by investing metal patterns in conventional denture investment flasks. A gypsum mould technique of investing was done to facilitate removal of the metal patterns from the flask. The metal patterns were invested. After the material had set on the lower half of the flask, another layer of gypusm material was added to cover the patterns and the mould. Subsequently after setting, the upper half of the flask was further supported entirely by gypsum material.[9,10] After the invested material had set, the flasks were separated, and the metal patterns were removed from the mould. DPI heat-cured denture base resin was proportioned and mixed following manufacturer's instructions. The resin was packed and polymerized in a water bath at 170°F for 9 hours. After processing, all specimens were bench-cooled for 30 minutes.[6]

All specimens were trimmed and polished to 11.5 x 9.1 x 39.5 mm, and were assessed for porosities. They were finished in a polishing machine using 320, 400, 600, 1000 grit sandpaper for 20 seconds on each of the four sides. Finishing and polishing was done using 1200[7] grit sandpaper for 10 seconds per side followed by a polishing rag and an alumina-oxide slurry solution for 10 seconds per surface. This left the blocks with a final dimension of 11 (±0.5) x 8 (±0.5) x 38(±0.5) mm.

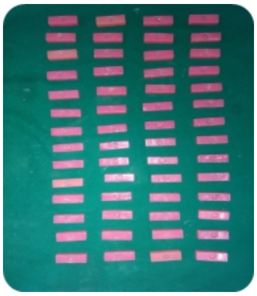


FIGURE 1: 60 HEATCURE RESIN BLOCKS

The Titanium housings (Alphadent) that were used had a dimension of 5mm diameter x 3.2mm height. These are composed of Ti-6Al-4V; which meets the specification of American Society for Testing and Materials (ASTM) F136. Each housing was composed entirely of the Titanium alloy that was subjected to an electrolytic passivation process called anodization,

At least 1.5mm of clearance is needed around and above each housing for maximum retention in the denture base[11], Attachment housings were set in the denture blocks as described below using four different repair techniques

Embedding the Implant Housings in Acrylic Blocks was then carried out

Group A:Autopolymerized acrylic resin(APAR) :After cleaning and drying of the drilled PMMA surface, liquid methyl methacrylate monomer was brushed on the exposed surface for 180 seconds to enhance adhesion of the repair material and the denture base resin.[6] Self-cure acrylic was applied using the sprinkle on technique. Once the resin filled ¾ of the hole, the denture block was inverted and placed over the titanium housing, simulating clinical implant supported overdenture attachment housing repair pick-up material. The denture block was pressed against a glass slab for 10 minutes. Using sprinkle on technique, additional self-cure resin was placed on the repaired side to fill any voids. Once set, the repaired surface with the attachment housing was re-polished.

Group B: Light Polymerized acrylic resin (LPAR)-Triad bonding agent was applied after cleaning and drying of the drilled area. It was left to settle for 2 minutes and then cured for another 2 minutes in the Triad curing unit (Triad 2000; Dentsply Trubyte, Pennsylvania, USA). Flowable resin was subsequently used to fill ¾ of the hole, and the denture block was inverted to pick-up the titanium housing, simulating clinical Implant overdenture attachment housing repair pick-up material;. The denture block was pressed against a glass slab and the resin was cured for 4 minutes while inverted, using a portable light-curing unit (Elipar S10 LED Curing Light; 3M ESPE St. Paul, Minnesota). Additional flowable resin was added around the housing to fill any voids and was initially cured for 4 minutes using a portable light-curing unit. Air Barrier Coating was applied on the light-cured resin to prevent inhibition of polymerization by oxygen1 and each block underwent final curing in the Triad curing unit for another 8 minutes. The repaired surface was then re-polished.

For Group C and Group D: Using Rocatec Junior, an abrasive blasting system, the titanium housing was sandblasted with silica-modified 30μm aluminium oxide (Rocatec Soft). A blast pressure of 2.8 bar was used for sandblasting. This was done to assure an adequate high level of energy to create the triboplasma. The surface was sandblasted at right angles from a distance of 1 cm for 15 seconds all around the titanium housing. It was then silanated for 15 seconds using RelyX Ceramic Primer (3M ESPE, St. Paul, Minnesota). Instead of using 3M ESPE Sil, 3M ESPE RelyX Ceramic Primer was used since it is made up of the same chemical compound (Methacryloxypropyltrimethoxy silane), the only difference is the water content and lack of Methyl Ethyl Ketone in the RelyX ceramic Primer.[11,12] Water evaporates slower than a ketone thus drying time is critical; therefore after silanation it was dried with air using a blow-drier for 15 seconds prior to attachment pick-up for adequate dryness of the silane solution since this was necessary to prevent incorporation of solvent molecules in the resin bonding layer which may weaken the interface.[8] Pick-up was accomplished using self-cure acrylic and light cure acrylic resin respectively with the same protocol. Once set, the repaired surface was re-polished.

All specimens were immersed in 37.6°C distilled water for a minimum of 30 days[3] for saturation in a 37°C incubation chamber (Queue Systems Inc, WV, USA). This is longer than that specified in ISO specification 1567:1999.1

The samples were divided into four groups and labelled A,B,C,D (FIGURE 2)

Group A: self-cured acrylic resin (DPI) ,

Group B : light-cured acrylic (Triad Gel; Dentsply Trubyte, Pennsylvania, USA) ,

Group C: self-cured acrylic (DPI)with sandblasted and silanated attachment housing

Group D: light-cured acrylic (Triad Gel; Dentsply Trubyte, Pennsylvania, USA) with sandblasted and silanated attachment housing

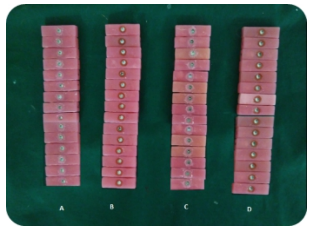


FIGURE 2 : IMPLANT ATTACHMENT HOUSINGS SECUREED IN THE FOUR GROUPS

The flexural strength of the repaired denture blocks with the attachment housings was measured during a three-point bending test using an Universal testing machine(FIGURE 3). The three point bending jig was set to have a span of 30mm, and a 5000N Instron load cell was used.Force was applied at the center of each block above the repaired area. The test was conducted at a crosshead speed of 5mm/min until failure occurred

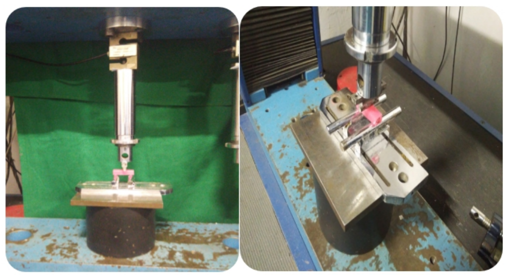


FIGURE 3 : THREE POINT BEND TEST USING UNIVERSAL TESTING MACHINE

Results and Discussion

The comparison of the flexural strength value of four different techniques to secure implant attachment housings to implant overdenture. . In vitro testing of the strength of acrylic blocks after the housings were attached.

The flexural strength values of the samples is given below:

GROUP A:Auto Polymerizing Acrylic Resin (APAR)			
Sr .no.	Sample No	Flexural Load	Flexural Strength
1	No.1	1344,56	40.00
2	No.2	934.92	31.80
3	No 3	656.60	19.53
4	No.4	775.18	27.90
5	No 5	703.64	25.33
6	No 6	833.00	27.20
7	No 7	961.38	28.60
8	No 8	838.88	30.19
9	No 9	1127.00	33.53
10	No 10	739.90	26.63

11	No 11	1168.16	42.05
12	No 12	725.20	26.10
13	No 13	760.48	27.37
14	No 14	593.88	21.37
15	No 15	663.46	23.88

GROUP B:Light Polymerizing Acrylic Resin (LAPAR)			
Sr .no.	Sample No	Flexural Load	Flexural Strength
1	No.1	814.38	24.22
2	No.2	587.02	21.13
3	No 3	730.10	24.77
4	No.4	908.46	23.65
5	No 5	964.32	28.69
6	No 6	755.58	22.48
7	No 7	966.28	28.74
8	No 8	572.32	20.60
9	No 9	716.38	23.39
10	No 10	733.04	26.38
11	No 11	847.70	30.51
12	No 12	817.32	29.42
13	No 13	759.50	27.34
14	No 14	906.50	32.63
15	No 15	606.66	21.76
Average			25.71

GROUP C:Autot Polymerizing Acrylic Resin with sandblasted and silanted attachments housings (APSAH)			
Sr .no.	Sample No	Flexural Load	Flexural Strength
1	No.1	895.72	29.24
2	No.2	1186.7	35.30
3	No 3	913.36	32.88
4	No.4	1075.0	31.98
5	No 5	988.82	39.44
6	No 6	771.26	22.94
7	No 7	1016.2	36.58
8	No 8	949.62	31.00
9	No 9	947.66	34.11
10	No 10	641.90	23.10
11	No 11	898.66	32.35
12	No 12	875.14	31.50
13	No 13	786.94	28.32
14	No 14	978.04	35.20
15	No 15	716.38	25.78
Average			31.31

GROUP D:Light polymerised acrylic resin with sandblasted and silanted attachments housings (LPSAH)			
Sr .no.	Sample No	Flexural Load	Flexural Strength
1	No.1	673.26	25.24
2	No.2	1000.5	29.76
3	No 3	616.42	22.19
4	No.4	918.26	29.98
5	No 5	1050.0	37.80
6	No 6	707.56	23.10
7	No 7	974.12	28.98
8	No 8	736.96	24.06
9	No 9	764.40	27.51
10	No 10	1202.46	43.28
11	No 11	843.78	30.37
12	No 12	957.46	34.46
13	No 13	746.76	26.88
14	No 14	532.14	19.15
15	No 15	851.62	30.65
Average			28.89

Results

Table 1: Comparison of flexural load (N) in terms of {Mean (SD)} among all the groups using ANOVA test

Group	No of samples	Mean (SD)
Group A	15	855.08 (214.2)
Group B	15	778.90 (127.9)
Group C	15	909.42 (139.9)
Group D	15	838.38 (180.1)
F value	-	1.516
P value	-	0.220

GRAPH 1 ACCORDING TO TABLE 1

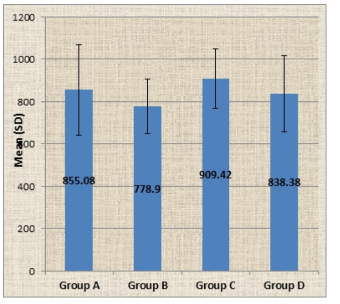


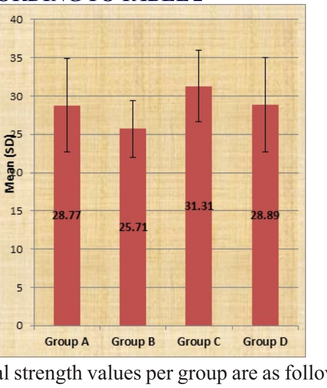
Table 2: Comparison of flexural strength (Mpa) in terms of {Mean (SD)} among all the groups using ANOVA test

Group	No of samples	Mean (SD)
Group A	15	28.77 (6.1)
Group B	15	25.71 (3.7) [a]
Group C	15	31.31 (4.7) [a]
Group D	15	28.89 (6.2)
F value	**-**	**2.800**
P value	**-**	**0.048***

(p < 0.05 - Significant*, p < 0.001 - Highly significant)**

(Same alphabets indicate significant difference using Tukey's post hoc analysis)

GRAPH 2 ACCORDING TO TABLE 2



The mean flexural strength values per group are as follows: self-cured acrylic was 28.76 MPa, light-cured acrylic was 25.71 MPa, self-cured acrylic with silanated attachment housing was 31.31MPa and light-cured acrylic with silanated attachment housing was 28.89MPa

TABLE 3
Multiple Comparisons
Dependent Variable: Flexural strength
Tukey HSD

(I) Group		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group A	Group B	3.05600	1.93925	.400	-2.0789	8.1909
	Group C	-2.54467	1.93925	.559	-7.6796	2.5902
	Group D	-.12400	1.93925	1.000	-5.2589	5.0109
Group B	Group A	-3.05600	1.93925	.400	-8.1909	2.0789
	Group C	-5.60067*	1.93925	.027	-10.7356	-.4658
	Group D	-3.18000	1.93925	.365	-8.3149	1.9549
Group C	Group A	2.54467	1.93925	.559	-2.5902	7.6796
	Group B	5.60067*	1.93925	.027	.4658	10.7356
	Group D	2.42067	1.93925	.599	-2.7142	7.5556
Group D	Group A	.12400	1.93925	1.000	-5.0109	5.2589
	Group B	3.18000	1.93925	.365	-1.9549	8.3149
	Group C	-2.42067	1.93925	.599	-7.5556	2.7142

*. The mean difference is significant at the 0.05 level.

(table2). Silanation is not consistent across repair material type. The interaction between the groups is presented in table 3.

Tukey's test was done since there was a significant interaction of the two effects (repair material and silanation). Based on Tukey's test (Table 1) there was no significant difference in means between non-silanated and silanated for light-cured acrylic groups, but there was for self-cured acrylic groups (p<0.0001). The effects of silanation and repair material type is not additive. The effects of silanation is dependent on which type of repair material was used.

Furthermore, the results revealed that self-cured acrylic with silanated attachment housing yielded the highest mean flexural strength values (p<0.0001) and is significantly different compared to the other groups, as shown in Table 3.

The null hypothesis was rejected as a significant difference was noted among the test groups.

The results of this study showed that the flexural strength of denture blocks repaired with self-cured acrylic plus the use of sandblasted and silanated attachment housing had the highest value compared with using self-cured acrylic alone, light-cured acrylic alone and light-cured acrylic with sandblasted and silanated attachment housing.

Furthermore, when the mean flexural strengths of both self-cured acrylic groups were compared with the two light-cured acrylic groups, self-cured acrylic groups rendered higher flexural strength values. This is in agreement with the studies done by Dar-Odeh et al.13 and Vojdani et al.14

Materials with the same composition have better bonding. To further support this, in a study done by Stipho et. Al4., Triad VLP reline material produced the greatest bond with the Triad VLP denture base resin.

May et al15. suggested that the shear bond strength of heat processed PMMA bonded to a machined surface of wrought CP titanium with 110 µm alumina air abrasion and a silane coating was 63% higher than the specimens with no pre-treatment.

Conclusion

Within the limitations of this study, the following can be concluded:

1. Flexural strength of self-cured acrylic with sandblasted and silanated attachment housing was significantly higher than self-cured, light-cured, and light-cured acrylic with silanated attachment housing groups.

2. Flexural strength of self-cured acrylic with and without sandblasted and silanation of attachment housing was significantly higher than the light-cured acrylic groups.

3. Sandblasting and Silanation produced higher flexural strength in denture blocks repaired with of self-cured acrylic.

Referrences

1. Batenburg rh, meijer hj, raghoebar gm, vissink a. Treatment concept for mandibular overdentures supported by endosseous implants: a literature review. Int J Oral Maxillofac Implants 1998;13:539-45.
2. Gonda T, Ikebe K, Dong J, Nokubi T. Effect of Reinforcement on Overdenture Strain. J Dent Res 2007; 86; 667.
3. Chee W, Jivraj S. Failures in implant dentistry. British Dental Journal 2007; 202 (3):123-129.
4. Stipho HD, Talic YF. Repair of denture base resins with visible light-polymerized reline material: Effect on tensile and shear bond strengths. J Prosthet Dent 2001;86:143-8.
5. Sarac YS, Sarac D, Kulunk T, Kulunk S. The effect of chemical surface treatments of different denture base resins on the shear bond strength of denture repair. J Prosthet Dent. 2005 Sep;94(3):259-66.
6. Azevedo A., Machado AL, Vergani CE, Giampaolo ET, Pavarina AC. Hardness of Denture Base and Hard Chair-side Reline Acrylic Resins. J Appl Oral Sci 2005; 13(3): 291-5.
7. Doundoulakis JH, Eckert SE, Lindquist CC, Jeffcoat MK. The implant-supported overdenture as an alternative to the complete mandibular denture. JADA 2003; 134: 1455-1458.
8. Eslamian L, Ghassemi A, Amini F, Jafari A, Afrand M. Should silane coupling agents be used when bonding brackets to composite restorations? An in vitro study. Eur J Orthod, Advance Access published on February 4, 2009; doi: doi:10.1093/ejo/cjn106.
9. Meng TR, Latta MA. Physical Properties of Four Acrylic Denture Base Resins. J Contemp Dent Pract 2005; (6)4:093-100.
10. Moradians S, Fletcher A M, Amin WM, Ritchie GM, Purnaveja J, Dodd AW. Somemechanical properties including the repair strength of two self-curing acrylic resins.
11. Guggenberger R. Rocatec System – adhesion by tribochemical coating. Dtsch Zahnarztl Z 1989; 44:874-6
12. Tan HK, Brudvik JS, Nichols JI, Smith DE (1989) Adaption of a visible light-cured denture base material. J Prosthet Dent 61:326–331
13. Dar-Odeh NS, Harrison A, Abu-Hammad O. An evaluation of self-cured and visible light-cured denture base materials when used as a denture base repair material. J Oral Rehabil. 1997 Oct;24(10):755-60
14. Vojdani M, Rezaei S, Zareeian L. Effect of chemical surface treatments and repair material on transverse strength of repaired acrylic denture resin. Indian J Dent Res. 2008 Jan-Mar;19(1):2-5.
15. May KB, Russell MM, Razzoog ME, Lang BR. The shear strength of polymethyl methacrylate bonded to titanium partial denture framework material. J Prosthet Dent.1993;70:410–413.