Scholars Journal of Dental Sciences (SJDS) **ISSN 2394-4951 (Print)**
Abbreviated Key Title: Sch. J. Dent. Sci. **ISSN 2394-496X (Online)**

A Unit of Scholars Academic and Scientific Society, India
www.saspublishers.com DOI:10.36347/sjds.2018.v05i05.013

Effect of Surface Treatments on the Bond Strength of Cross Linked Acrylic Resin Denture Teeth with Auto-Polymerized Acrylic Resin – An In Vitro Study

Dr. I. Krishna Chetan*, Dr. Pranav V Mody, Dr. Suhas Rao K, Dr. Avinash kumar
Dept. of Prosthodontics, K. V. G Dental College and Hospitals, Kurunjibhag, Sullia, Karnataka, India

Original Research Article

***Corresponding author**
Dr. I. Krishna Chetan

Article History
Received: 11.05.2018
Accepted: 19.05.2018
Published: 30.05.2018

DOI:
10.21276/sjds.2018.5.5.13

Abstract: To evaluate and compare the effects of chemical and mechanical treatment of the ridge lap surface of acrylic teeth on the bond strength of acrylic resin teeth to denture base resins. A total of 40 specimens were acrylized using heat-polymerized acrylic resin with specific dimensions which has a ditch of specific dimension on the superior surface and molar tooth was arranged on the superior surface. The specimens were divided into 4 groups according to the treatment done on the ridge lap area and then subjected to hardness test using universal testing machine. Statistical analysis was done using one way ANOVA test and Tukey HSD post hoc test. Group C showed maximum bond strength and Group A showed the minimum bond strength. Group B & D showed increase in bond strength compared to control group. Sandblasting the ridge lap area and treating it with chemical agents like methyl methacrylate monomer and acetone increases the bond strength with denture base acrylic resin significantly.
Keyword: Heat cure acrylic resin; Self cure acrylic resin; Acrylic teeth.

INTRODUCTION

The use of a dental prosthesis is indispensable for functional and aesthetic rehabilitation of edentulous patients improving their oral health related quality of life [1,2]. Structures fashioned to resemble denture bases carved out of hardwood, ivory or bone with natural teeth held by screws or other means were reported to be ancient dentistry. However this material presented aesthetic as well as fabrication challenges [3,4].

Acrylic resin was introduced as a denture base material in 1937 by Dr. Walter Wright. PMMA (Poly Methyl Methacrylate) continues to be used as a denture base materials because of its favorable working characteristics, ease of processing, accurate fit, stability in oral environment, superior esthetics and use with inexpensive equipment[5].

Acrylic resin teeth for dentures were introduced in 1940[6]. Denture teeth made of acrylic resin are preferred over porcelain teeth because they chemically bond to denture base materials and are easier to adjust. Authors that evaluated the frequency of various denture repairs found tooth de-bonding to be the most frequent problem requiring repair of conventional prosthodontics [7].

Given that one of the advantages of acrylic teeth is the ability to chemically bond to denture base resins, one probable explanation for this type of failure would be the presence of impurities on the tooth surface. Impurities could include residual wax because of incomplete elimination or contamination of the ridge-lap surfaces with tin-foil substitute. Such materials can prevent chemical bonding between acrylic teeth and denture base resins [8].

It has been estimated that between 22% and 33% of denture repairs involve tooth de-bonding usually in the anterior region of the denture which is highly unacceptable. The de-bonding of anterior teeth may be attributed to a lesser ridge lap surface available for bonding and the direction of stresses encountered during function [9].

Bonding can be influenced by mechanical or chemical modification of the ridge lap portion of acrylic resin denture teeth before processing [10]. Mechanical preparation improves the bond strength but has failed to show any substantial effect [11]. And comparatively, the technique requires more time and labor. There is also conflicting evidence regarding the benefit of chemical surface treatment of the teeth, as the effect seems to depend on the brand of tooth and denture base resin [10].

Hence the present study was under taken to evaluate and compare the effects of chemical and

mechanical treatment of the ridge lap surface of acrylic teeth on the bond strength of acrylic resin teeth to denture base resins.

METHODOLOGY

Preparation of the specimens

Total specimens were divided into four groups which differed on the basis of surface treatment of ridge lap area of cross linked acrylic teeth.
Groups were as following-

Group A- The ridge lap area of cross linked acrylic tooth was left untouched and untreated; this was used as control group.

Group B- The ridge lap area of cross linked acrylic tooth was subjected to sand blasting as surface modification.

Group C -The ridge lap area of cross linked acrylic tooth was subjected to sand blasting as surface modification and chemically treated with methyl methacrylate monomer.

Group D- The ridge lap area of cross linked acrylic tooth was subjected to sand blasting as surface modification and chemically treated with acetone.

METHOD OF DATA COLLECTION

Wax blocks of dimension 8mm x 10mm x 40mm were prepared with modelling wax. The superior surface was having a ditch of 3mm x 10 mm x 10mm. Flasking and de-waxing of wax blocks was done following standard technique. After de-waxing, heat-polymerized acrylic resin was packed into the mold space following manufacturer's instructions and processed by conventional technique. Specimens were bench cooled overnight for 10 hours at room temperature. De-flasking was done carefully and the acrylic blocks were carefully retrieved.

The acrylic blocks were finished with sand paper and then polished with polishing cake. The ditch was filled with modelling wax and then the molar teeth were arranged on the superior surface. Flasking and De-waxing of wax blocks was done following standard technique.

After careful de-waxing, the ridge lap area of 10 cross linked acrylic tooth was left untouched and untreated; this was used as control group.

The ridge lap area of 10 cross linked acrylic tooth was subjected to sand blasting with aluminum oxide of 50 -100 microns as surface modification.

The ridge lap area of 10 cross linked acrylic tooth was subjected to sand blasting with aluminum oxide of 50 -100 microns as surface modification and methyl methacrylate monomer was applied with paint brush 3 times and left to dry for 15 minutes.

The ridge lap area of 10 cross linked acrylic teeth was subjected to sand blasting with aluminum oxide of 50 -100 microns as surface modification and acetone was applied with paint brush 3 times and left to dry for 15 minutes.

Auto-polymerized acrylic resin was mixed according to manufacturer's instruction. The ditch was filled with auto-polymerized resin when it reached dough stage. The flask was closed once again and kept under hydraulic bench press at 1000 psi for 15 minutes. Specimens were retrieved.

Measurement of bond Strength

The equipment used for measuring the bond strength was universal testing machine.

Statistical Analysis

Data was analysed using one way ANOVA and The Tukey HSD Post Hoc test was used to find significance between the groups.

RESULTS

Four experimental groups were made on basis of surface treatment of ridge lap area of cross linked acrylic teeth for this study.
Groups are as following-
Group A - The ridge lap area of cross linked acrylic tooth was left untouched and untreated, this was used as control group.
Group B - The ridge lap area of cross linked acrylic tooth was subjected to sand blasting as surface modification.
Group C -The ridge lap area of cross linked acrylic tooth was subjected to sand blasting as surface modification and chemically treated with methyl methacrylate monomer.
Group D - The ridge lap area of cross linked acrylic tooth was subjected to sand blasting as surface modification and chemically treated with acetone.

The values were subjected to statistical analysis

Statistical analysis done using ANOVA for comparing bond strength between all the groups it revealed that, there was statistical significance ($p<0.0001$) Table: 1

Statistical analysis done using POST HOC TUKEY TEST for comparing mean difference and std error between all the groups Table: 2

Table-1: The table shows mean load of four study groups for bond strength along with standard deviation, standard error, lower bound and upper bound at 95% Confidence Interval for Mean and P value. (One way ANOVA)

GROUP	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P value
					Lower Bound	Upper Bound	
1	10	13.9683	1.55116	0.49052	12.8587	15.0779	0.000
2	10	20.5389	3.23323	1.02244	18.2260	22.8518	
3	10	34.6522	6.58389	2.08201	29.9424	39.3620	
4	10	20.5555	3.12441	0.98803	18.3204	22.7906	

Table-2: This table shows comparison of mean difference, std. error and significance between all the groups. (Tukey HSD post hoc test)

Groups	Mean difference	Std. error	Sig.
Group 1	-6.57060*	1.81617	0.005
Group 2			
Group 1	-20.68390*	1.81617	0.000
Group 3			
Group 1	-6.58720*	1.81617	0.005
Group 4			
Group 2	-14.11330*	1.81617	0.000
Group 3			
Group 2	-0.01660	1.81617	1.000
Group 4			
Group 3	14.09670*	1.81617	0.000
Group 4			

* The mean difference is significant at the 0.05 level.

DISCUSSION

Bond failure could either be adhesive or cohesive. Adhesive failure occurs if there is no trace of any denture base resin on the tooth surface after the fracture, cohesive failure occurs if there is presence of any trace denture base resin on the surface of denture teeth or remnants of the denture tooth on the denture base. The denture teeth often separate from the denture base without causing any damage to the denture base or teeth predominantly indicating adhesive failure[7].

Many authors have studied the effect of surface modification such as: placement of vertical or horizontal retentive grooves[11] treating the ridge lap area with methyl methacrylate monomer [12,13], dichloromethane[14] or a combination of methyl methacrylate monomer with sandblasting [13] the ridge lap area with 50µ or 250µ aluminum oxide; to improve the bond strength between denture base resin and acrylic resin teeth with three different surface modifications of the ridge lap area were evaluated and compared with that of unmodified teeth [15].

Earlier studies in which the ridge lap area was sandblasted with 50µ of aluminum oxide showed marginal improvement in the bond strength. However a study by Chung *et al.* [13] revealed that sandblasting the ridge lap area with 50µ could only remove the glaze on the ridge lap area but had no significant effect in improving the bond strength between the denture base resin and acrylic resin teeth. Chung *et al.* [13] also reported that sandblasting the ridge lap area 250µ of aluminum oxide particles under 5 kg cm of pressure with a circling motion from a distance of 8mm distance for 5 seconds significantly increased the bond strength between acrylic resin teeth and denture base resin. In this present study, sandblasting the ridge lap area with aluminum oxide had increased the bond strength when compared with the control group (group 1) which is against the conclusion of Barpal *et al*. [10].

The swelling phenomenon of acrylic resin polymer teeth due to the diffusion of monomer from the denture base polymers was demonstrated by Vallittu *et al*. [16] and by increasing the polymerizing temperature, the monomer of the denture base polymers diffused more effectively into acrylic resin polymer teeth. This increased the bond strength between the polymer teeth and the denture base polymer. Whereas in the present study, the ridge lap area of control group samples (group 1) was left untreated to assess the original bond strength between acrylic teeth and denture base resin without the influence of mechanical factors.

The acrylic resin teeth bonded to high impact denture base resin was significantly influenced by modification of the ridge lap area before processing. Many authors described use of different solvents like methyl methacrylate, Diethyl ether, chloroform, acetone etc. Treating ridge lap area with acetone showed

increase in bond strength. Therefore, the monomer infiltration into the pits and cracks formed by acetone treatment of the ridge lap area results in superior adhesion between the acrylic teeth and denture base resin[17]. In this present study use of acetone (group 3) increases the bond strength compared to control group (group 1).

In most specimens, the fracture occurred at the tooth and denture base resin interface. Group 3 (sandblasting and treating with methyl methacrylate monomer) recorded the highest mean bond strength of 34.65 Mpa. Control group recorded the least mean bond strength of 13.96 Mpa. Whereas only sandblasted and acetone treated with sandblasting showed 20.53 Mpa and 20.55 Mpa respectively. Comparison of mean bond strength of each group was evaluated and their standard deviation was tabulated.

The one-way ANOVA for variables shows that interaction between the groups is highly significant (P value < 0.01). Therefore treating the ridge lap area with chemicals helps in increasing the bond strength compared to that of the untreated ridge lap area.

Comparison of variables between different groups was done by employing Tukeys HSD test. The result made it evident that the mean bond strength between acrylic resin teeth and denture base resin was enhanced significantly by surface modification of the ridge lap area when compared to that of the unmodified surface. This is probably because the roughening of ridge lap area allows more penetration of chemicals into the polymer network of teeth.

Hence sandblasting the ridge lap area and treating it with methyl methacrylate monomer increases the bond strength with denture base acrylic resin significantly.

Limitation of the study

The present study method and variables do not represent all clinical conditions. Despite this limitation, the materials evaluated in this study are expected to perform similarly in oral environment.

Thermocycling was not considered in this study. Thermocycling is a treatment that theoretically allows repeated expansion and contraction of the tooth and denture base resin components, thereby stressing the bond and simulating the oral conditions. The second benefit of thermocycling is the hydration of the specimen, which would further simulate the clinical condition; however, previous studies showed the bond strength of hydrated and un-hydrated specimens produce similar results with acrylic resins. It is well accepted that in vivo performance does indeed differ from an in vitro settings.

Clinical Significance

When repairing a denture in situations involving debonding acrylic resin denture teeth, clinician should use chemical agents with sand blasting on the ridge lap area to obtain optimal bond strength with the auto polymerized repair acrylic resin.

CONCLUSION

Within the limitations of this study, the following conclusions were drawn: The mechanical treatment of the ridge lap area of acrylic resin teeth significantly increased the bond strength.

The chemicals like methyl methacrylate monomer and acetone are more effective in increasing the bond strength in roughened ridge lap area when compared to the glossy surface of ridge lap area.

Application of methyl methacrylate monomer on roughened ridge lap area significantly increased the bond strength.

REFERENCES

1. Dhir G, Berzins DW, Dhuru VB, Periathamby AR, Dentino A. Physical properties of denture base resins potentially resistant to candida adhesion. J prosthodont 2007;16:465-72.
2. Ellis JS, Pelekis ND, Thomason JM. Conventional rehabilitation of edentulous patients: the impact on oral health-related quality of life and patient satisfaction. J prosthodont 2007;16:37-42.
3. Peyton FA. History of resin in dentistry. Dent Clin North Am 1975;19:211-22.
4. Smith DC. The acrylic denture, mechanical evaluation of midline fracture. Br. Dent. J 1961;110:257-67.
5. John J, Gangadhar SA, Shah I. Flexural strength of heat polymerized poly methyl methacrylate denture resin reinforced with glass, aramid or nylon fibers. J Prosthet Dent 2001;86:424-7.
6. Kelly GB. Has the advent of plastics in dentistry provided great scientific value. J Prosthet Dent 1940; 1:168
7. Meng G K, Chung KH, Stark MLF, Zhang H. Effect of surface treatments and cyclic loading on the bond strength of acrylic resin denture teeth with auto-polymerized repair acrylic resin. J Prosthet Dent 2010; 103:245-52
8. Marra J, Desouza RF, Barbosa DB, Pero AC, Compagnoni MA. Evaluation of the Bond Strength of Denture Base Resins to Acrylic Resin Teeth: Effect of Thermocycling. Journal of Prosthodontics 18 (2009) 438–43.
9. Darbar UR, Huggett R, Harrison A. Denture fracture – a survey. Br. Dent J 1994;176:342-5.
10. Barpal D, Curtis DA, Finzen F, Perry J, Gansky SA. Failure load of acrylic resin denture teeth bonded to high impact acrylic resins. Journal of Prosthetic Dentistry. 1998 Dec 1;80(6):666-71.

11. Cardash HS, Liberman R, Helft M. The effect of retention grooves in acrylic resin teeth on tooth denture-base bond. The Journal of prosthetic dentistry. 1986 Apr 1;55(4):526-8.
12. Barbosa DB, Monteiro DR, Barao VA, Pero AC, Compagnoni MA. Effect of monomer treatment and polymerisation methods on the bond strength of resin teeth to denture base material. Gerodontology. 2009 Sep 1;26(3):225-31.
13. CHUNG KH, Chung CY, Chung CY, Chan DC. Effect of pre-processing surface treatments of acrylic teeth on bonding to the denture base. Journal of oral rehabilitation. 2008 Apr;35(4):268-75.
14. Arima T, Nikawa H, Hamada T. Composition and effect of denture base resin surface primers for reline acrylic resins. The Journal of prosthetic dentistry. 1996 Apr 1;75(4):457-62.
15. Clancy JM, Hawkins LF, Keller JC, Boyer DB. Bond strength and failure analysis of light-cured denture resins bonded to denture teeth. The Journal of prosthetic dentistry. 1991 Feb 1;65(2):315-24.
16. Vallittu PK, Lassila VP, Lappalainen R. Wetting the repair surface with methyl methacrylate affects the transverse strength of repaired heat-polymerized resin. The Journal of prosthetic dentistry. 1994 Dec 1;72(6):639-43.
17. Krishna VP, Premalatha A, Babu PJ, Raju DS, Kumar MP, Rao DB. Effect of various chemicals on the bond strength of acrylic tooth and denture base -An In-vitro comparative study. J Int Oral Health 2014;6(1):100-5.