An evaluation of the effect of retention means on increasing the debonding strength of the denture acrylic teeth attached to the denture base resin

Abbas F. Al-Huwaizi B.D.S., M.Sc., Ph.D.[(1)]

ABSTRACT

Background: The debonding of acrylic teeth from the denture base is a challenging problem to the dentist and dental technician in which special means must be done to increase the debonding strength of the tooth.

Material and method: Sixty specimens of acrylic central incisors were attached to acrylic rods and grouped into 5 groups according to the shape of the retention means placed at the tooth ridge lap. The specimens were strained under tension to examine their debonding strength.

Results: The teeth with serrations (Group 2) have shown to be the most effective mean of increasing debonding strength, followed by the 2 longitudinal grooves (Group 4) where the difference between these groups was insignificant. Then followed by the teeth with 4 holes, and finally the difference between the teeth with a central groove and the control group were insignificant.

Conclusions: It is recommended that the tooth ridge lap should be serrated with a fissure groove or placement of the 4 grooves to increase the debonding strength of the tooth.

Key words: Debonding force, acrylic denture teeth. **(J Coll Dentistry 2005; 17(1): 14-17)**

INTRODUCTION

Although the finite element method is a useful technique of stress analysis, because a single sample is used for the analysis, no controls are available and the results cannot be calibrated. It is important therefore that the results obtained are validated against standard experimental methods.[(1)] It was therefore, planned by the author to confirm the results obtained from the previous finite element study dealing with the stress distribution at the resin tooth/denture tooth interface with this experimental study.[(2)]

The tooth/denture resin interface has been addressed in many previous studies.[(2-9)] Researches have studied modifying the tooth ridge lap chemically in order to increase the bond between the tooth and the denture base resin. As some researchers placed adhesive material on the ridge lap, or attempting to increase the temperature of curing in order to increase the penetration of the monomer of the denture base in the acrylic resin polymer teeth.[(3,4,5,6)] Other researchers have found that contamination of the tooth ridge lap with chemicals and/or impurities may decrease the debonding strength or not affect it at all.[(3,6,7,8)]

While some studies have investigated increasing the bond by physical means as placing grooves of scratches.[(3,9)]

Anyhow, researches using the finite element analysis, [(1,2)] have found that placement of retention grooves or other retention means increases the debonding strength of the acrylic teeth when compared with the unmodified teeth.

MATERIALS AND METHODS

The specimens consisted of an acrylic tooth (central incisor) and attached to it a rod of acrylic 5mm in radius and 2.5cm in length (Fig.1). The acrylic rod was first made out of wax then a heavy body silicone impression mould was done to fabricate the other wax patterns of the acrylic rods, where molten wax was poured in the mould. After that the 5mm end of the wax patterns were carefully placed of the ridge lap surface of the acrylic tooth. Then the combination of the acrylic tooth and the wax pattern were placed in a denture flask to substitute the wax with acrylic and curing occurred.

The total sample was 60 specimens divided into 5 groups, where each group contained 12 specimens.

All the grooves and retention means were placed at the tooth ridge lap within the 5mm circle of attachment between the tooth and the acrylic rod (Fig.2) and they were made using a fissure bur.

The groups were categorized according to the shape of the retention means as follows (Fig. 3):

Group 1 (Control): There was no modification to the tooth ridge lap.

(1) Lecturer, Department of Prosthodontics, College of Dentistry, University of Baghdad.

Group 2: There are 4 grooves (1mm radius and 1mm depth), they were placed at the points representing the 12 o clock, 3 o clock, 6 o clock, and 9 o clock markings on the clock.

Group 3: Four serrations 3mm long and 0.5mm in depth were placed horizontally one over the other by 1mm.

Group 4: One central groove which is 2mm in depth and 2mm in diameter.

Group 5: Two longitudinal grooves (4mm long and 1mm in depth) placed 0.5mm away from the central line dividing the 5mm circle into 2 equal halves.

During testing of the specimens for their debonding force, they were held by clamps which loaded the inner surface of the tooth ridge lap and the bulged area at the end of the acrylic rod. The specimens were strained under tension using the Instron Universal testing machine at a cross head speed of 2.5mm/min to monitour the tooth debonding force.

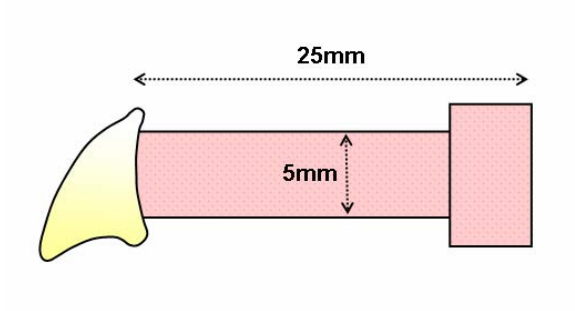

Figure 1: The specimen of the tooth attached to the acrylic rod.

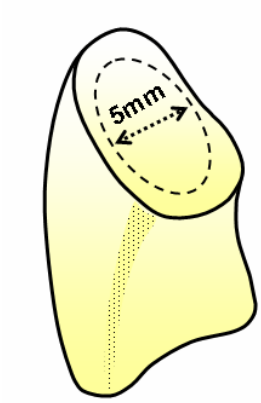

Figure 2: The area of contact between the tooth and the acrylic rod.

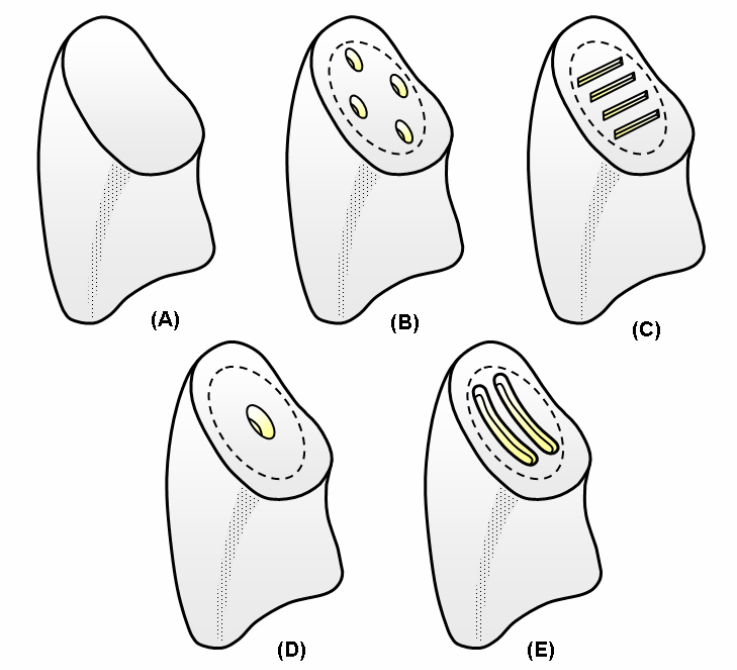

Figure 3: The groups and their ridge lap modifications. Group 1, control (A), Group 2 (B), Group 3 (C), Group 4 (D), and Group 5 (E).

Statistical Analysis:

ANOVA and T-tests were used to examine the differences between the groups. P values of more than 0.05 were regarded as statistically insignificant. Three levels of significance were used:

* $0.01 < p \leq 0.05$, ** $0.001 < p \leq 0.01$, *** $p \leq 0.001$

RESULTS

The results obtained represented the debonding force of the acrylic teeth (tensile strength). The descriptive analysis of the results (Table 1 and figure 4) showed a variation in the mean values between the groups with the value of group 3 being the highest, while the mean of group 4 was the lowest.

ANOVA test revealed a significant difference between the five groups (Table 2). However, t-test showed that showed that there is no significant difference between group 1 (control) and group 2 and between group 3 and 5 as shown in table 3.

DISCUSSION

It can be concluded that the debonding strength of acrylic teeth can be increased by the addition of serrations to the tooth ridge lap. This coincides with the findings of Al-Huwaizi [2] in a finite element study and Cunningham et al. [3] who found that scratched tooth ridge laps provided the highest tensile strength.

Longitudinal grooves added to the tooth ridge lap were found to be second best. This retention mean was also found be effective by Cardash et al..[9] However, placement of one central hole showed a reduced debonding strength and placement of four holes showed a comparable debonding strength to that of the control group. This comes in agreement with the findings of previous studies.[2,3,9]

Placement of serrations or longitudinal groove was proved to improve debonding strength of the acrylic teeth to the acrylic denture base resin. This may be because of the distribution of the forces along the whole ridge lap surface. However, a central groove may have increased strength in the centre of the ridge lap with no effect on the peripheries of the ridge lap. Moreover, such a small hole may play as a site for stress concentration rendering the tooth more liable to fracture of the denture base. Which coincides with the results of Vallittu P.K. et. al. [10] who reported that surface irregularities, whether macroscopic or microscopic, can act as stress concentration areas leading to fracture.

Table1: Mean debonding force analysis of the 5 groups.

Group	N	Mean	S.D.	Minimum	Maximum
Gp 1 (control)	12	309.583	14.994	280	330
Gp 2	12	319.583	23.496	280	360
Gp 3	12	376.250	19.321	345	410
Gp 4	12	279.167	18.443	240	305
Gp 5	12	356.250	26.554	310	400
Total	60	328.167	40.169	240	410

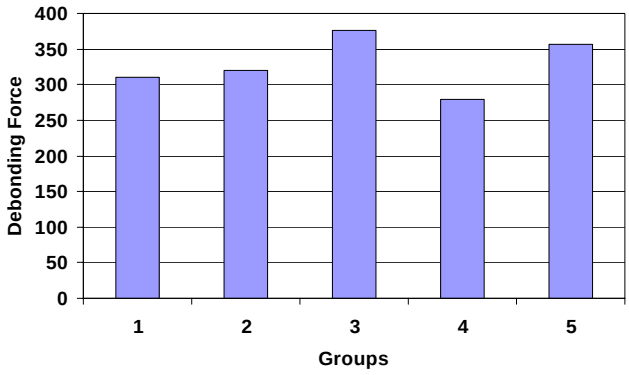

Figure 4: Mean debonding force of the 5 groups.

Table 2: ANOVA test between the 5 groups.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	71048.333	4	17762.083	40.452	0.000
Within Groups	24150.000	55	439.091		
Total	95198.333	59			

Table 3: T-test between the 5 groups.

First group	Second group	t value	p value	Significance
Gp 1 Control	Gp 2	-1.243	0.238	NS
Gp 1 Control	Gp 3	-9.443	0.000	***
Gp 1 Control	Gp 4	4.433	0.001	**
Gp 1 Control	Gp 5	-5.301	0.000	***
Gp 2	Gp 3	-6.453	0.000	***
Gp 2	Gp 4	4.687	0.001	***
Gp 2	Gp 5	-3.582	0.004	**
Gp 3	Gp 4	12.591	0.000	***
Gp 3	Gp 5	2.110	0.057	NS
Gp 4	Gp 5	-8.259	0.000	*

d.f.=22

REFERENCES

1- Darbar UR, Huggett R, Harrison A. Finite element analysis of stress distribution at the tooth-denture base interface of acrylic resin teeth debonding from the denture base. J Prosthet Dent 1995; 74: 591-4.

2- Al-Huwaizi AF. Effect of retention grooves on stress distribution at the resin tooth/denture resin interface. A finite element study. J Coll Dent 2004; 16(1): 7-10.

3- Cunningham JL, Benington IC. An investigation of the variables which may affect the bond between plastic teeth and denture base resin. J Dent 1999; 27: 129-35.

4- Vallittu PK, Ruyter IE. The swelling phenomenon of acrylic resin polymer teeth at the interface with denture base polymers. J Prosthet Dent 1997; 78:194-9.

5- Morrow RM, Matvias FM, Windeler AS, Fuchs RJ. Bonding of plastic teeth to two heat curing denture base resins. J Prosthet Dent 1978; 39(5): 565-8.

6- Abu-Anzeh MA, Al-Dhaher A. Evaluation of tensile bond strength of tooth-denture base resin as a function of different surface treatment and processing regimes. A master thesis, College of Dentistry, Baghdad University, 2003.

7- Catterlin RK. Effect of tinfoil substitute contamination on adhesion of resin denture tooth to its denture base. J Prosthet Dent 1993; 69: 57-9.

8- Darbar UR. The effect of impurities on the stress distribution at the tooth/denture base resin interface. Asian J Aesthet Dent 1994; 2: 7-10.

9- Cardash HS, Applebaum B, Baharav H, Liberman R. The effect of retention grooves on tooth-denture base bond. J Prosthet Dent 1990; 64(4): 492-6.

10- Vallittu PK, Alakuijala P, Lassila VP, Lappalainen R. In vitro fatigue of an acrylic resin-based partial denture: An exploratory study. J Prosthet Dent 1994; 72: 289-95.