

## ORIGINAL ARTICLE

# Comparison of Type of Denture Teeth and Cyclic Loading on the Bond Strength in Acrylic Denture Base

Fatemeh Nematollahi<sup>1</sup>, Zohreh Asgari<sup>2\*</sup>, Sima Shahabi<sup>3</sup> and Loghman Ghahremani<sup>4</sup>

1- Assistant Professor, Department of Prosthodontics, School of Dentistry, Tehran Islamic Azad University, Tehran, Iran

2- Student of Dentistry, School of Dentistry, Tehran Islamic Azad University, Tehran, Iran, (zh.asgari@yahoo.com)

3- Associate Professor, Department of Dental Biomaterials, School of Dentistry/Laser Research Center in Dentistry/Research

Center for Science and Technology in Medicine, Tehran University of Medical Sciences, Tehran, Iran

4- Assistant Professor, Department of Prosthodontics, School of Dentistry, Orumiye University of Medical Sciences, Orumiye, Iran

### ABSTRACT

Much research on simulated oral environment with thermo cycling (temperature and humidity create a similar environment of the mouth) and Cyclic Loading (chewing force) is not performed in the present study has been undertaken. Given the shortcomings of the statements that most manufacturers of beauty composite denture teeth comparable to wear them with acrylic teeth, this study aimed to compare the effects of 4 kinds of dentures (dental composite (multi-lytic) and acrylic (Monolitik) Ideal shuttle and Ivoclar ) with and without Cyclic Loading on the bond strength of denture base acrylic denture in the School of Dentistry, Islamic Azad University, was designed and implemented. The results showed that, in the absence of Cyclic Loading, high bond strength of dental acrylic Ivoclar lowest bond strength of dental composite was Ivoclar. The percentage of failures with the highest failure rate in all groups was tested using cohesive. The percentage breakdown of the highest failure rate in all groups tested, within the tooth.

**Keywords:** Dentures, Cyclic Loading, SBS, Ivoclar acrylic, Cohesive

Received 24/10/2014 Accepted 20/01/2015

©2015 Society of Education, India

### How to cite this article:

Fatemeh N, Zohreh A, Sima S and Loghman G. Comparison of Type of Denture Teeth and Cyclic Loading on the Bond Strength in Acrylic Denture Base. Adv. Biores., Vol 6 [2] March 2015: 39-45. DOI: 10.15515/abr.0976-4585.6.2.3945

## INTRODUCTION

Tracheostomy is one of the most prevalent surgical methods in the intensive care unit which has been done under the general or local anesthesia. [1]. the purpose of doing tracheostomy is to keep the respiratory airway of patient by making a hole on the wall of trachea.

Separation of acrylic dentures, denture base is one of the major problems and significant in patients who are wearing dentures [1] Research and studies to evaluate the frequency and repeat the modification and repair dentures been paid, to the conclusion that repair dentures, denture connection, often rising [2 and 3] Due to the increasing use of prosthetic implants and the subsequent increase in force, detachable dentures become larger clinical problem, where Jemt as the most common complaint referred prosthesis [4] With the increasing use of artificial teeth, discussion and research in this field has also increased. In research conducted by researchers over the years, it has been reported that the physical and chemical changes in the structure of dentures and consumer base acrylic polymers can be changed bonding [5] Today in our country dentures are made by reputable manufacturers the dentures are made of cheap, competition with foreign material and it is easy to access. Bond strength was evaluated a number of Iranian artificial teeth [6 and 7].

Unfortunately, the new type of composite material is for flaws have come to market a variety of acrylic, careful scientific assessment has been done in laboratories. If this situation continues, the time and cost of

material and human losses back to the dentist and the patient has to bear the costs. The time of the patient and the dentist is also the other side [4].

Review of the research that has been done in this case it is clear that the lack of integrity in laboratory procedures, laboratory work and has created several problems in scientific experiments and expressed there are many problems in the bond issue that requires further investigations [8, 9 and 10] Moreover, according to the research that has been done in the country, much research on simulated oral environment with thermo cycling (temperature and humidity create a similar environment of the mouth) and Cyclic Loading (chewing force) is not performed it has been considered in the present study. Given the above shortcomings and statements of most manufacturers of composite denture teeth and beauty comparable to wear them with acrylic teeth, this study aimed to compare the effects of 4 kinds of artificial teeth (dental composite (multi-lytic) and acrylic (Monolitik) Ideal shuttle and Ivoclar) with and without Cyclic Loading on the bond strength of denture base acrylic denture School of Dentistry, Islamic Azad University, was designed and implemented.

### **HYPOTHESES**

1. If the dental composite resin, acrylic Ivoclar is connected, most of the dental composite resin heat Glamour connected the bond strength.
2. If the dental acrylic resin baking heat connected, most of the dental composite resin, acrylic binds the bond strength.
3. If the tooth does not fall under Cyclic Loading, most of the time when teeth are placed under Cyclic Loading bond strength.
4. Teeth to Cyclic Loading has more impact on the bond strength.

### **MATERIAL AND METHODS**

The experimental study (Experimental) and in vitro (In vitro) was performed. The 8 groups were evaluated on the basis of the research were: Iranian Glamour composite teeth, dental composite Ivoclar Liechtenstein, New coral dental acrylic, acrylic teeth Ivoclar Liechtenstein apply Cyclic Loading absence of Cyclic Loading. Based on a pilot study of bond strength equal to  $69/1 \pm 1/11$  in group B and group D is equal to  $03/2 \pm 81/7$ . Given the above numbers with a confidence level of 95% ( $\alpha$ ) and test power of 90% ( $\beta$ ) and the total number of samples in each group, 10 of 80 samples were studied. Sampling and sample preparation was based on the goal. After sample preparation laboratory data of each sample was recorded. The dependent variable in this study, there are two categories: one category includes quantitative variables (SBS) and other categories of qualitative variables (type and location of the break).

#### **How to conduct research**

Dental composite material used in this study Glamour (G), dental composite Ivoclar (Ic), acrylic teeth New Coral (M), acrylic teeth Ivoclar (Ia), acrylic resin, acrylic is Dentsply.

Group A: Tooth G / by applying (GC) Cyclic Loading

Group B: Dental G / without (G) Cyclic Loading

Group C: Dental Ic / by applying (IcC) Cyclic Loading

Group D: tooth Ic / without (Ic) Cyclic Loading

Group E: tooth M / by applying (MC) Cyclic Loading

Group F: Dental M / without (M) Cyclic Loading

Group G: Tooth Ia / by applying (IaC) Cyclic Loading

Group H: Dental Ia / without (Ia) Cyclic Loading

First of all samples using the same cutting machine (ISOMET low speed saw, Buehler, Germany) at a rate of 2 mm from the surface of the teeth were removed Ridge lap until smooth. That first dental wax (Modeling wax, Red, Cavex, Holland) was melted and the generator pack. The artificial tooth in place of a generator with an angle of 135 degrees (Maxillary incisor teeth angle relative to the mandibular incisor teeth in occlusion, type I) was connected embedded in wax and then carefully removed from the mold. Then the samples into Poti (Coltene, Swiss Speedex,) placed so that all the seals were in Poti. Within each Mfl (Mfl brass Hanv- USA) 3 samples took place. Namely, the lower half Mfl, dental plaster (Iran, Persia teeth, Pluster typeII) shed and samples from the Poti Poti to the edge of the stone sank. After exactly 20 that was set in plaster. Vaseline is applied on plaster and putty plaster was put back on the samples. After hardening putty, Mfl upper half and placed in dental plaster (Iran, Persia teeth, Pluster typeII) in the upper half and Mfl was poured for 45 minutes in the press (Press / von Trier barking KFP / Iran) pressure was 50 kg. Mfl to 1 to 2 minutes then put in boiling water was soft wax Soft wax with the boiling water and soap (safflower / Paxan / Iran) were washed to remove the connection from any contamination. After the plaster has dried while still hot by brush (MR. Dental biofilm / Red / UK / England) tinfoil substitute plaster was applied to the surface Mfl temperature room temperature [11].

Acrylic resin (Selectaplus H / Travelon, Dentsply, England) were mixed according to the manufacturer's instructions, at the dough stage (Dough) in place and remove the wax in contact with the teeth and pack it with a scalpel to make additions were made. Then press Mfl under pressure for 10 minutes was 100 kg. After that, Mfl in tightly closed Clamp [11] and resin manufacturer's recommended temperature and when cooked. After the polymerization is complete, the flask was cooled to room temperature; the samples were removed from the Mfl. After the samples were removed, cleaned and additions acrylic. At 37 ° C for 2 ± 50 hours were stored in distilled water [1] Then around 5000 by thermo cycling under heat in cold water with a temperature of 4 ° C and hot water temperature was 55 ° C. As for the placement of each tank 30 (S) and the interval is between the two cylinders 20 (S). Each sample was then coded specimens were randomly assigned to the Operator. Then using, half of the subjects in the center of the device for generating Cyclic Loading (Alborz, Taksazan Idea co. Iran,) with plaster (Iran, Persia teeth, Gypton type II) were fixed. While the samples were placed in distilled water at 37 ° C under the Load 1.2 Hz / 50N to 14,400 times were Cyclic Loading device (17, 13), as the force of Singolom was exactly 3/1 central incisors. Then examined in the bond strength Shear (SANTAM STM- Universal testing machine) (20 / KOREA with BONGSHIN / Model: Load cell) 200Kgf) DBBP-200 / Capacity under shear angle of 135 degrees (the incisal edge) were used. The "Universal Test" is made up of different parts. It has taken many forms and applications Eplicotors different. In this study, we used the blade on one side of the chamfer (bevel) and the other was smooth. UTM device to clamp the specimen was fixed. Activation of the applicator (blade) speed mm / min1 started to move down (14). The maximum force before the sudden loss of power (Breakforce), which is indicative of cracks in the sample, as the power failure was detected. Site of fracture were reviewed to determine the type of failure.

## RESULTS

A) The mean bond strength tested MPa in Table 1 is as follows:

As can be seen in Table 1 the highest average bond strength of the group H (Ivoclar acrylic teeth without Cyclic Loading) and the lowest bond strength is also related to the group C (Ivoclar dental composites by applying Cyclic Loading). 1) In the absence of Cyclic Loading, Ivoclar highest bond strength of acrylic teeth to the 64/1 ± 94/14 and the lowest bond strength of dental composite Ivoclar the difference in the rate of 37/2 ± 43/9 51.5 MPa and 36%, respectively. ANOVA test showed a statistically significant difference between the bond strength of the teeth is (P <0.001) and Tukey HSD multiple comparisons test showed additional and the bond strength of dental acrylic teeth more Ivoclar New coral and there is statistical significance (P < 0.08). But there is no significant difference between the dental composite Gamvr and Ivoclar composite.

2) In the exercise of Cyclic Loading, high bond strength of dental acrylic Ivoclar 83/1 ± 59/13 and the lowest bond strength of composite resin to the tooth Ivoclar 04/2 ± 11/9, respectively. ANOVA analysis showed that among the four types of teeth tested after Cyclic Loading statistically significant difference (P <0.001) Tukey HSD multiple comparisons post-test showed no significant difference between the two teeth Ivoclar New acrylic and acrylic coral (P <0.07) but no significant difference between the two dental composite Ivoclar Glamour.

3) When applying Cyclic Loading is always reduced bond strength and the greatest loss of teeth and the rate was 9% acrylic Ivoclar and minimum reduction of dental acrylic and new coral and 2% respectively. But this difference was not statistically significant (P <0.7).

**Table 1: The mean bond strength of different groups tested**

C.V	Domain	Amount	(Mpa)
			Experiment group
20	7.19-12.36	10.21±1.78	(GC)A
16	6.78-12.52	10.64 ±1.42	(G)B
23	6.12-12.83	9.11 ± 2.04	(IcC)C
26	5.23-12.59	9.43 ± 2.37	(Ic)D
24	8.84-14.74	11.98 ± 2.13	(MC)E
15	8.96-4.29	12.23 ± 1.33	(M)F
21	10.86-15.94	13.59 ± 1.83	(IaC)G
18	12.02-17.33	14.94 ± 1.64	(Ia)H

B) The failure frequency of failure (if classified into two groups: Cohesive and Adhesive) in Table 2. In each of these groups are:

As seen in the table is generally 5/87% of the samples (70) cohesive failure of the 5/12% others [10] Adhesive is a failure. In group E (acrylic coral New to Cyclic Loading), G (acrylic Ivoclar or Cyclic Loading) and H (acrylic Ivoclar acts of Cyclic Loading) all of cohesive failure. The maximum frequency is of Adhesive type of group B (composite Glamour without Cyclic Loading) and 30% (3) respectively. Fisher's exact test showed that between the first and second types of dental practices and absence of Cyclic Loading on the type of failure, there is no significant difference (P <0.2).

**Table 2: Distribution of samples based on the failure to separate the groups tested**

Total	In place of teeth	In teetn or in base	Number Frequency	Failure
	(Adhesive)	(Cohesive)		Group
10(100%)	2(20%)	8(80%)	(GC)A	
10(100%)	3(30%)	7(70%)	(G)B	
10(100%)	2(20%)	8(80%)	(IcC)C	
10(100%)	2(20%)	8(80%)	(Ic)D	
10(100%)	0(0%)	10(100%)	(MC)E	

10(100%)	1(10%)	9(90%)	Number Frequency	(M)F
10(100%)	0(0%)	10(100%)	Number Frequency	(IaC)G
10(100%)	0(0%)	10(100%)	Number Frequency	(Ia)H
80 (100%)	10(12.5%)	70(87.5%)	Number Frequency	Total

C) The failure frequency of failure (if classified into four groups: the failure of the tooth, the base acrylic, at the junction of the teeth and acrylic) in each group were tested in Figure 1.

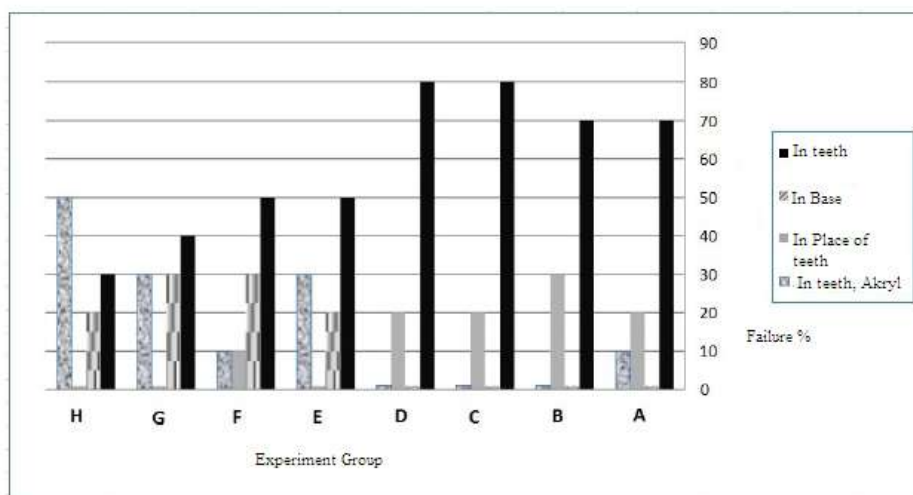


Figure 1: Distribution of samples in terms of the failure to separate groups

## DISCUSSION AND CONCLUSION

\* A summary of results is presented here:

- In the absence of Cyclic Loading, high bond strength of dental acrylic Ivoclar lowest bond strength of dental composite was Ivoclar. ANOVA test showed a statistically significant difference between the bond strength of the tooth there and further Tukey HSD multiple comparison test showed that the bond strength of dental acrylic teeth Ivoclar New corals but there is no significant difference between the dental composite Glamour and Ivoclar composite. In terms of actions Cyclic Loading, high bond strength of dental acrylic lowest bond strength of dental composite was Ivoclar . ANOVA analysis showed that among the four types of teeth tested after Cyclic Loading statistically significant difference. Further tests showed Tukey HSD multiple comparisons between two teeth Ivoclar and new corals but significant differences between the teeth and acrylic composite Ivoclar Glamour and there is no significant difference.

- The impact of Cyclic Loading on bond strength, this study showed that exercise is always bond strength decreased Cyclic Loading the greatest loss of teeth and the rate was 9% and the lowest Ivoclar decline of coral new dental acrylic and 2% respectively.

But this difference is not statistically significant. So Cyclic loading effect on bond strength of denture base acrylic resin dentures were studied.

- The percentage of failures with the highest failure rate in all groups was tested using Cohesive. Adhesive failure group (Ia) H, (IaC) G, (MC) E was observed. Fisher's exact test showed that between the teeth and Second Acts and the absence of Cyclic Loading on the type of failure, but there is no significant difference in clinical terms is controversial.

- In view of the failure of the highest failure rate in all groups tested, within the tooth.

\* In effect on bond strength of denture teeth, several studies have been conducted.

Here are the results of the present study were to compare the history of empirical research:

- Kawara et al [12], in his study of flexural connection strength test, which showed significantly higher bond strength of dental acrylic teeth monolithic multiple lytic base acrylic resin composite polymerization itself is binding. In both of these dental bonding resin polymerizes spontaneously cured acrylic resin was significantly higher than the acrylic resin is most cohesive failure of [12]. The flexural strength of connection is measured in the present study was to evaluate the shear bond strength to strength. However, the results of the above study are confirmed.

- Takahashi et al. [13] in Japan, two types of denture adhesive force compared with three types of resin. The results of this study indicate that the acrylic teeth to dental composite bonding strength are higher. The acrylic resin also showed superiority over other resins [13]. The results of this study, this study confirms.

- Clancy and Boyer in 1989 and 1991 in two separate studies bond is strength three conventional resin with acrylic teeth and tooth wear resistant IPN True to form bio-byte years. In both of these studies showed in both acrylic resin dentures and teeth strong bonding to conventional acrylic resin baking heat, significantly higher bond strength of tooth wear resistant but spontaneously polymerize the resin bond strength of resin not differ between the two types of teeth [14 and 15]

The research was conducted in 1989 did not identify the type and location of failures, but in 1991 Clancy Boyer pick up the slack and they used electron microscopy to identify the location and type of failure. Since the majority of failures in both acrylic resin teeth Cohesive and thus the bond strength of dental acrylic teeth in both the acrylic resin is desirable. In these two studies measured the tensile bond strength to strength with shear bond strength was investigated in the present study. The differences are in the materials and methods of research and study on a line.

- Majid Nasser and colleagues [7] in a study in which they compared the bond strength of acrylic teeth (Ivoclar Liechtenstein, Ivoclar Italy, New Coral, Diamond, Super Diamond and Super Niokalr) Acrylic Resin paid. The results showed that the bonding of acrylic teeth Ivoclar Liechtenstein teeth was significantly higher than 5.

Cohesive failure of the majority [7] The tensile bond strength of the force measured in the present study was to evaluate the shear bond strength to strength. Despite the differences in the teeth, a study confirms these results.

• Cyclic Loading on effect on bond strength is limited. Here are the results of the present study was to compare the history of empirical research:

- Diaz Arnold et al [16] in a study of the impact of Cyclic Loading on the flexural strength of denture base resins were investigated. The results showed that after 10,000 times under Cyclic Loading Load with 5 Hz difference in flexural strength of acrylic resin and polymerized self-Light was created

However, in our study the effect of Cyclic Loading on the flexural strength of denture base resins were investigated, while the present study the effect of Cyclic Loading on shear bond strength of denture base acrylic dentures were investigated. The present study also showed that under Cyclic Loading Load with 1.2 Hz / 50N to 14,400 times a significant effect on bond strength of denture base acrylic teeth to no heat.

- Chung and colleagues (2010), in a study of the impact of changes in the level of Cyclic Loading on the shear bond strength of denture acrylic denture base acrylic self-polymerize spontaneously evolved. The results showed that under Cyclic Loading Load with 2 Hz / 22N to 14,400 times a significant effect on bond strength of denture base acrylic teeth were more failures of Adhesive [17]

Cyclic Loading in the study had a significant influence on the failure of this aspect, the present study confirms but the failure of non-conformity with the present study is that this could be due to differences in the type of denture base resin.

- Since the study of failures created in all groups tested is a Cohesive (Although the failure was not statistically significant but clinically there is debate) it can be concluded that the bond strength of dental acrylic teeth and acrylic base strength is investigated. Ivoclar especially acrylic teeth that were all Cohesive failure, adhesive failure at 5/12%, the rest is probably the result of carelessness and pollution in the dental laboratory work has been or acrylic.

- Although the difference was not statistically significant at the break, but the clinic is open to discussion, so it can be said that a lot of failures in the tooth in the dental composite average (Glamour and Ivoclar) than acrylic teeth (New coral and Ivoclar) was observed, which could be due to multiple lytic composite teeth and lower resistance connection between the central part of the composite layer resistant to wear and acrylic. While it integrated and Monolithic made of acrylic teeth. However, in the present study because the losses have not been studied with electron microscope certainly cannot be said that the failure occurred in the dental composite resin exactly at the junction of the composite layer and the central portion is find the probability that a failure has occurred at this location.

- The study of connection all teeth and acrylic base 25 mm square was identical in all samples. Since it is assumed sign in alternating cycles of force during the denture function, fatigue and consequently teeth. The humidity and temperature can bond strength of denture teeth and denture base acrylic effective. In this study, due to the limitations and conditions of the experiment thermo cycling and Cyclic Loading the teeth are ways to simulate the environment, by applying [18 and 19]The results showed that the Cyclic Loading significant effect on bond strength of denture base acrylic dentures with no heat.

- Since most failures created in all groups of Cohesive been tested. (Although the failure was not statistically significant, but the difference between them is controversial clinical) the significant difference between the different types of clinical value is expressed in terms of bond strength.

Because in all cases it is desirable to base acrylic dental bonding strength and because of the strength of the bond or acrylic teeth and thus the force, but the teeth or acrylic resin teeth uncut or both left and failure is established. Due to the fact there are different groups can be interpreted as follows:

- In terms of actions and non-actions Cyclic Loading, acrylic teeth significantly higher breakdown strength of the dental composite showed. Due to poor bond between resins composite layer and the central part of the strength of the dental composite of multiple lytic Monolithic acrylic teeth less. The result will fail sooner than acrylic teeth (most failures in all the teeth in the teeth). Probably due to a better quality of

dental acrylic teeth, acrylic Ivoclar New corals, failure Ivoclar acrylic teeth with greater force than the acrylic teeth, which took place in New Coral significant difference between acrylic teeth and acrylic Ivoclar New coral justifies. The failure of the tooth above the tooth composite Glamour Ivoclar composite was probably due to better quality dental composite to the tooth Glamour Ivoclar approved by the American Dental Association is, of course, the difference was not statistically significant.

- in all four types of teeth by applying Cyclic Loading bond strength decreased, probably due to the forces and stresses exerted on the teeth during Cyclic Loading. However, this difference was not statistically significant. In this research Load entered the tooth was 14,400. Future research may Load entered the number of teeth, the difference was significant.

## REFERENCES

1. Barbosa DB, Ricardo Barao VA, Monteiro DR, ET al. Bond strength of denture teeth to acrylic resin: effect of thermo cycling and polymerization methods. *Gerodontology* 2008 ; doi :10.1111/j . 1741-2358 .2008 .00218.
2. Craig KG, Powers JM, wataha JC. *Dental material properties and manipulation*, 7thed . Saint louis : Mosby; 2000; 257-281.
3. Cunningham JL. Shear bond strength of resin teeth to heat-cured and light-cured denture base resin. *J Oral Rehab* 2000; 27: 312-316.
4. Jemt T. Failures and complications in 391 consecutively inserted fixed prosthesis supported by Branemark implants in edentulous jaws: A study of treatment from the time of prosthesis placement to the first annual checkup. *Int J oral maxilla Implants* 1991: 6:270-76.
5. Cunningham JL. Bond strength of denture teeth to acrylic bases. *J Dent* 1993; 21: 274-280.
6. Shahabi Sima, Qdvy Hussein. The bond strength of three Iranian dentures or dentures denture base resins Ivoclar (Ivoclar). *Journal of Islamic Dental Association / Volume 16, Number 4, 2004, pp. 44-52.*
7. Naser Majid Khaki, E. shadow. The bond strength of four ideal types of denture fabrication factory Maku, Iran and the two countries, Liechtenstein and Italy Ivoclar dental acrylic denture base. *Medical martyr martyr Medical University Dental Journal*, 2007, Volume 25, No. 3, 310-315.
8. 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: 129-135.
9. Cunningham JL, Benington IC. Bond strength variations of synthetics resin teeth in dentures. *Int J Prosthet* 1995; 8:69-72.
10. Darbar UR, Hugget R, Harrison A. Denture fracture : A survey. *Br Dent J* 1994; 176: 342.
11. K. Butcher, Bolndr g, translated by Ali specific. It charts the prosthetic treatment of edentulous patients Press, 2004. First edition, section 3. rehabilitation of edentulous patients: making complete dentures: 344-348.
12. Kawara M, Carter JM. Ogle RE, Johnson RR. Bonding of plastic teeth to denture base resins. *J Prosthet Dent* 1991;66:566-71.
13. Takahashi Y, Chai J, Takahashi T et al. Bond strength of denture teeth to denture base resin. *Int J Prosthodont* 2000;13:59-65.
14. Clancy JMS, Boyer DB. Comparative bond strengths of light-cured, heat-cured and polymerizing denture resins to denture teeth. *J Prosthet Dent* 1989; 61:457-462.
15. Clancy JM, Hawakins LF, Keller JC, Boyer DB. Bond strength and Failure analysis of light cured denture resins bonded to denture teeth. *J Prosthet Dent* 1991; 65:315-324.
16. Diaz-Arnold AM, Vargas MA, Shaull KL, et al: Flexural and fatigue strengths of denture base resin. *J Prosthet Dent* 2008;100:47-51.
17. Graham K. Meng, Kwok-Hung Chung, Madelyn L. Fletcher-Stark, Hai Zhang. Effect of surface treatment and cyclic loading on the bond strength of acrylic resin denture teeth with autopolymerized repair acrylic resin. *J Prosthet Dent* 2010;103:245-252.
18. Drummond JL, Bapna MS: Static and cyclic loading of fiber-reinforced dental resin. *Dent Mater* 2005;19:226-231.
19. Garoushi SK, Lasslia LVJ, Vallittu PK: Fatigue strength of fragmented incisal edges restored with a fiber reinforce drestorative material. *J Contemp Dent Practice* 2007;8:1-10.