

# Effect of Different Curing Methods on Tensile bond Strength Soft Acrylic Liner to Heat-Cured Acrylic Resin

**Alaa' N Al-Saraj**  
BDS, MSc (Asst.Lec.)

**Marwah M Shehab**  
BDS, MSc (Asst.Lec.)

**Reem N Al- Irhaym**  
BDS MSc (Asst.Lec.)

**Department of Prosthetic Dentistry**  
College of Dentistry, University of Mosul

**Department of Prosthetic Dentistry**  
College of Dentistry, University of Mosul

**Department of Prosthetic Dentistry**  
College of Dentistry, University of Mosul

## الخلاصة

**الأهداف:** لتقييم تأثير طرق الطبخ المختلفة على قوة شد الارتباط بين مادة تبطين الاكريليك المرنة ومادة قاعدة الطقم الاكريليك الحار. **المواد وطرق العمل:** تم تحضير أربعة وعشرون عينة من قاعدة الطقم الاكريليك الحار وقسمت إلى أربع مجاميع: - الأولى مطبوخة بطريقة الحمام المائي والثانية معالجة بالمونمر مطبوخة بطريقة الحمام المائي والثالثة مطبوخة بطريقة الموجات الدقيقة اما المجموعة الأخيرة فكانت معالجة بالمونمر و مطبوخة بطريقة الموجات الدقيقة. تم قياس قوة شد الارتباط باستخدام جهاز انسترون لقياس قوة الشد. **النتائج:** دل تحليل البيانات المجموعة على وجود فرق معنوي في قوة شد الارتباط للمجاميع قيد الدراسة. **الاستنتاجات:** أظهرت الدراسة إن قوة شد الارتباط بين مادة تبطين الاكريليك المرنة ومادة قاعدة الطقم الاكريليك الحار المطبوخ بطريقة الحمام المائي أفضل من طريقة الموجات الدقيقة.

## ABSTRACT

**Aims:** To evaluate the effect of different curing methods on tensile bond strength between soft acrylic liner and heat cured acrylic resin denture base. **Materials and methods:** Twenty four specimens were prepared from Vertex heat cured acrylic resin and divided into four groups: cured by water bath, treated by monomer and cured by water bath, cured by domestic microwave oven and treated by monomer and the last group cured by domestic microwave oven at same setting. Instron tensile testing machine was used for tensile bond strength test. **Results:** There is a significant differences between tensile bond strength of tested groups ( $p=0.001$ ) for the different curing methods. **Conclusions:** The curing of soft acrylic liner by water bath had better tensile bond strength compared to microwave curing.

**Key words:** tensile bond strength, soft acrylic liner, curing methods.

Al-Saraj NA, Shehab MM, Al- Irhaym RN. Effect of Different Curing Methods on Tensile bond Strength Soft Acrylic Liner to Heat-Cured Acrylic Resin. *Al-Rafidain Dent J.* 2011; 11(2): 292-296.

**Received:** 13/1/2010 **Sent to Referees** 18/1/2010 **Accepted for Publication:** 4/4/2010

## INTRODUCTION

The clinical use of denture lining materials was first reported in 1943. Soft denture liners are applied for denture wearers who cannot tolerate a hard-based denture due to a thin and non-resilient oral mucosa and/or severe alveolar resorption. This material distributes and absorbs masticatory forces by means of the cushioning effect. Clinical success of the materials depends both on their viscoelastic properties and on durability.<sup>(1-3)</sup>

A microwave is an electromagnetic wave having a wavelength in the microwave region. Although, this region is not bound by definition, it is commonly regarded as extending from 300,000 megacycles to 100 megacycles per second

(MHz). This corresponds to wavelengths between 1 mm and 30 cm longer wavelengths (thus lower energy) than infrared rays, but shorter than those of radio and TV.<sup>(4)</sup> Microwaves can be used to generate heat inside the resin.<sup>(5)</sup>

Nishi was the first one used microwave energy to polymerize denture base materials.<sup>(6)</sup>

Microwave energy can cure polymethyl methacrylate (PMMA) resins efficiently in a short time with clean performance using simple technique and ordinary household microwave oven<sup>(7)</sup> and prevent internal porosity in resins and heighten the degree of polymerization<sup>(6,8,9)</sup> but in thick sections there is a risk of porosity.<sup>(4)</sup>

With standard laboratory procedures,

the microwave technique can improve and simplify denture relines.<sup>(10)</sup>

The application of microwave energy for curing is a dielectric heating method in which the immediate heating take place and both the surface and the deeper part of the resin are heated rapidly and uniformly.<sup>(11)</sup>

The microwave polymerization of the resilient soft denture liner reduces the potential warpage of the denture base that can occur during the conventional process of boiling in water for 2 hours. Additionally, microwave irradiation reduces processing time to less than 1 hour, allowing the dentist the opportunity to reline a patient's denture in a single visit. The technique is simple and requires no extensive or elaborate dental laboratory equipment.<sup>(12)</sup>

Akesi-Ilbay and Ilbay compared the tensile bond strengths of soft lining materials polymerized by using conventional water bath methods and microwave energy and found that conventional water bath technique is better than microwave technique.<sup>(13)</sup>

Baysan *et al.*, used 650 W microwave energy for 3, 5, and 10 minutes for processing a silicone soft lining material and found that this method of polymerization does not compromise the strength of a soft lining material and its adhesion to polymethyl methacrylate.<sup>(14)</sup>

Twenty four specimens were prepared form heat-cured acrylic resin(Vertex ,Holland)and divided into two main groups for curing by two different curing methods(water bath or microwave). Each sample consist of two pieces (each piece was prepared separately with dimensions of(3x10x40mm thickness x width x length respectively)<sup>(15)</sup> and stored in distilled water at 37±1°C for 48 hours using incubator. Each group divided into two subgroups: in the first group the specimens were treated with monomer at the two faced surfaces. In the second group the specimens were left untreated. All the specimens then they were placed in stone mold prepared with dimensions of 3x10x90mm (thickness x width x length respectively) maintaining 10 mm gap between the two prepared acrylic denture pieces <sup>(16)</sup> Figure (1)These gaps were was filled with dental soft acrylic liner (Vertex,Holland) at the mid way. The specimens of the first group were cured by water bath (according to its manufacturer instruction) and the specimens of the second group were cured by domestic microwave oven (LG, Korea) at 540 Watt for 5minutes. Before testing all the specimens were stored in distilled water at 37±1°C for 48 hours in incubator.The specimens were tested by placing tension until fracture occurred using universal tensile testing machine (WolPert ,Germany) at a across head speed of 5mm/min.<sup>(17)</sup>

## MATERIALS AND METHODS

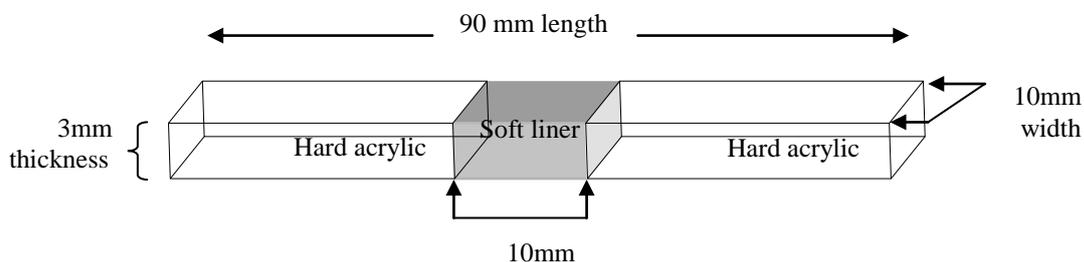


Figure (1): Diagram of tensile test specimens.

The collected data were analyzed by (One Way ANOVA) and Duncan's multiple range test at  $P \leq 0.05$ .

## RESULTS

Mean and standard deviation of tensile strength for water bath and microwave cured specimens are showed in Table (1).

Table(1): Mean and standard deviation of tensile strength for water bath and microwave cured soft acrylic liner.

Groups	Mean ± SD	No. of specimens
W	1.1617±0.56135	6
WT	1.3485±0.19138	6
M	0.6825±0.20498	6
MT	0.6418±0.20498	6

W:curing by water bath without treatment; WT : curing by water bath with treatment ; M: curing by microwave bath without treatment; MT: curing by microwave with treatment.

The analysis of variance (one way ANOVA) is illustrated in Table (2) and confirmed that there is a significant differences between tensile bond strength of tested groups ( $P = 0.001$ ) Duncan's multiple range test of the tensile strength for different curing methods is shown in Figure (2) and revealed that the group that

treated with monomer and cured by water bath have the highest mean value of tensile strength ( $1.3485 \pm 0.19138$ ) and the microwave cured groups that treated with monomer have the lowest mean value ( $0.6418 \pm 0.20498$ ).

Table (2): Analysis of Variance (ANOVA) of Tensile Strength for Water bath and Microwave Cured Soft acrylic liner .

Source of variance	D f	Sum of Squares	Mean Square	F-value	p-value
Curing methods	3	1.902	0.634	7.969	.001
Error	18	1.432	0.080		
Total	21	3.335			

D f: degree of freedom, Significant at  $p \leq 0.05$

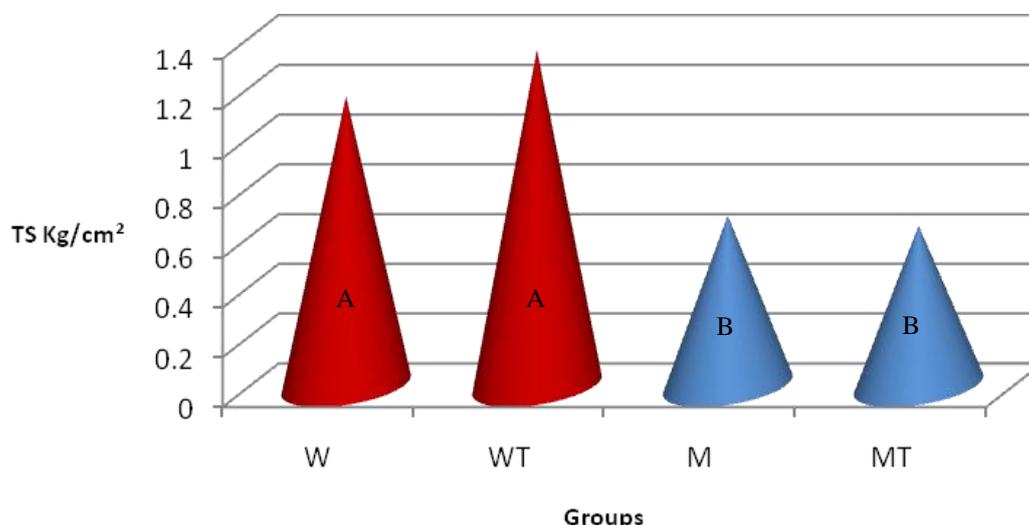


Figure (2): Mean of Tensile Strength for Water Bath cured and Microwave Cured Permanent Soft liner with or without Treatment.

W:curing by water bath without treatment; WT : curing by water bath with treatment ; M:curing by microwave without treatment; MT : curing by microwave with treatment

### DISCUSSION

The results showed that the tensile bond strength of water bath cured specimens was significantly higher than specimens cured by microwave this can be explained as follow;

tensile bond strengths of soft acrylic denture liners to the denture base resin were lower with an increase in plasticizer content<sup>(18)</sup> and the residual monomer act by a plasticizing effect

which effectively reduces interchain forces, so that deformation could occur more easily under load.<sup>(19)</sup>

The results showed that the tensile bond strength of water bath cured specimens was significantly higher than specimens cured by microwave this can be explained as follow; Microwave curing at low wattage for 30 minutes with an additional 1.5-minute at high wattage, rather than shorter times at higher wattage, increased the level of monomer conversion and produced a low level of residual monomer<sup>(18)</sup> and the residual monomer act by a plasticizing effect which effectively reduces interchain forces<sup>(19)</sup> and as the tensile bond strengths of soft acrylic denture liners to the denture base resin were lower with an increase in plasticizer content<sup>(20)</sup> In this study the high microwave power (540 Watt) and short time (5 minutes) may result in higher residual monomer content compared to the water bath curing method in which a 30 minutes terminal boil was used which result in higher residual monomer conversion that result in higher tensile bond strength.

The results also revealed that the specimen treated with monomer and cured by water bath have higher tensile bond strength than untreated specimen but not reach the significant level this difference may be due to painting the surface of acrylic resin by monomer softens and dissolves the acrylic resin surface to enhance the bond of reline material dough to the acrylic denture base material such surface treatment cause a superficial crack propagation as well as formation of numerous pits. This surface morphologic change may enhance the mechanical retention between fractured surface and reline material associated with the monomer penetration and polymerization along the reline material.<sup>(21-25)</sup>

Other clarification is that the bond between acrylic denture base and reline materials is chemical, so it is important to achieve acrylic denture base surface clean and free of contamination of dental laboratory such as wax, and separating medium. Therefore, treatment of acrylic denture base surface with monomer is essential to obtain clean surface; thus it increases the old – new denture base bond

strength<sup>(26)</sup> The result of this study disagreed with Akesi-Ilbay and Ilbay and Baysan *et al.*,<sup>(13,14)</sup> who stated that microwave polymerization does not compromise the strength of a soft lining material and its adhesion to polymethyl methacrylate.

## CONCLUSION

This study concluded that curing by water bath resulted in significantly higher tensile bond strength compared to microwave curing method. Treating the surface with monomer showed no significant effect tensile bond strength of tested specimens.

## REFERENCES

1. Nikawa H, Yamamoto T, Hayashi S, Nikawa Y, Hamada T. Growth and/or acid production of *Candida albicans* on soft lining materials in vitro. *J Oral Rehabil.*2007; 21(5): 585-94.
2. Garcia CM, Leon LT, Oliveira MB, Del Bel Cury AA. Effect of a denture cleansers on weight, surface roughness, and tensile bond strength of two resilient denture liners. *J Prosthet Dent.*2003; 89(5): 489-94.
3. Murata H, Hamada T, Sadamori S. Relationship between viscoelastic properties of soft denture liners and clinical efficacy. *Japanese Dental Science Review.* 2008; 44(2): 128-132.
4. Al-Doori D, Huggett R, Bates J, Brooks S. A comparison of denture base acrylic resins polymerised by microwave irradiation and by conventional water bath curing systems. *Dent Mater.*1988; 4: 25-32.
5. Clerck J. Microwave polymerization of acrylic resins used in dental prostheses. *J Prosthet Dent.*1988; 57(5): 650-658.
6. Nishi M. Studies on the curing of denture base resins with microwave irradiation with particular reference to heat curing resin. *Osaka Dental University.*1968; 2: 23-40.
7. Khayat AB. Application of microwave energy in the polymerization of acrylic resins. M.SC. Thesis, College of Dentistry, University of Baghdad.1989.
8. Seals RR, Cortes A, Funk JJ, Parel SM. Microwave techniques for fabrication of provisional facial prostheses. *J Prosthet Dent.*1989; 62: 327-31.

9. Barbosa DB, Compagnoni MA, Leles CR. Changes in occlusal vertical dimension in microwave processing of complete dentures. *Braz Dent J.* 2002;13(3): 197-200.
10. Turck MD, Richards MW. Microwave processing for denture relines, repairs, and rebases. *J Prosthet Dent.* 1992; 69: 340-3.
11. Blagojevic V, Murphy VM. Microwave polymerization of denture base materials. A comparative study. *J Oral Rehabil.* 1999; 26: 804-808.
12. McKinstry RE. Microwave processing of permanent soft denture liners. *Compendium.* 1991; 12(1) 32-7. (Abstract)
13. Akesi-Ilbay S, Ilbay SG. A comparison of bond strengths of soft denture liners to polymethyl methacrylate polymerized by conventional water bath and microwave curing techniques. *J Marmara Univ Dent.* 1993; 1(4): 327-32. (Abstract).
14. Baysan A, Parker S, Wright PS. Adhesion and tear energy of a long-term soft lining material activated by rapid microwave energy. *J Prosthet Dent.* 1998; 79(2): 182-7.
15. Ozkan YK, Sertgoz A, Gedik H. Effect of Thermocycling on Tensile bond strength of Six Silicone Based Resilient denture liner. *J Prosthet Dent.* 2003; 89: 303-310.
16. Al-Omari AWR. Evaluation of some mechanical and physical properties of re-lined acrylic denture base material by using different curing techniques. M.Sc. Thesis, College of Dentistry, University of Mosul. 2005.
17. Al-Azzawi SI. Evaluation of some physical and mechanical properties of acrylic denture base material cured by two different type of microwave irradiation. M.Sc thesis, College of Dentistry, University of Baghdad. 1998.
18. Arab J, Newton JP, Lloyd CH. The effect of an elevated level of residual monomer on the whitening of a denture base and its physical properties. *J Dent.* 1989; 17: 189-194.
19. Hong G, Murata H, Hamada T. Relationship between plasticizer content and tensile bond strength of soft denture liners to a denture base resin. *Dent Mater J.* 2004;23(2):94-99.
20. Shen C, Colaizzi A, Birns B. Strength of denture repair as influenced by surface treatment. *J Prosthet Dent.* 1984; 52: 844-848.
21. Arima RT, Ikawa NH, Amada H, Arsini H. Composition and effect of denture base resin surface primers for reline acrylic resins. *J Prosthet Dent.* 1996; 75: 55-56.
22. Nagai E, Otani K, Satoh Y, Suzuki S. Repair of denture resin using woven metal and glass fiber: effect of methylene chloride pretreatment. *J Prosthet Dent.* 2001;85:496-500.
23. Leles CL, Machado RA, Vergani CE, Giampaolo ET, Pavarina AC. Bonding strength between a hard chairside reline resin and a denture base material as influence by surface treatment. *J Oral Rehabil.* 2001; 28: 1153-1157.
24. Rached RN, Del-Bel Cury A A. Heat-cured acrylic resin repaired with microwave -cured one: bond strength and surface texture. *J Oral Rehabil.* 2001; 28: 370-374.
25. Vallittu PK, Lassila PV, Lappalainen R. Wetting the repair surface with methacrylate affect the transverse strength of repair heat- polymerized resin. *J Prosthet Dent.* 1994; 72: 639-643.
26. Vergani CE, Machado AL, Giampaolo EL, Pavarina AC. Effect of surface treatment on the bond strength between composite resin and acrylic resin denture teeth. *Int J Prosthodont.* 2000; 13: 383-386.