Evaluation of the Bond Strength of Three Soft Lining Materials to Acrylic Resin Denture Base

Munther N. Kazanji  
BDS, MSc (Asst Prof.)

Asmaa A Abid Al-Kadder  
BDS, MSc (Asst Lect.)

Abstract

Aims: The aims of this study were to evaluate the effect of different surface treatments and different periods of water storage on tensile bond strength of three soft lining materials. Materials and methods: Two hundred sixty four (264) specimens have been prepared. Surface treatments used for bonding Molloplast – B liner included roughening acrylic surface with bur, and treatment with primo adhesive. For bonding Bony plus liner, roughening acrylic surface with bur, treatment with liner’s liquid and combination of both treatments have been evaluated. For GC Reline liner, roughening acrylic surface with bur has been evaluated.Befor tensile bond testing of molloplast-B liner’s specimens they were stored for(1 day or 1 month or 4 months), while Bony plus and GC Reline liners’ specimens were stored for(1 day or 1 week or 1 month) and then tested. Results: The results showed that roughening acrylic surface had an insignificant effect on (TBS) of GC Reline liner and Bony plus liner (although these materials showed cohesive failure). Bony plus liner’s liquid treatments had significant improvement in (TBS) of this liner. Different periods of water storage had insignificant effect on (TBS) of Molloplast-B liner and GC Reline liner, but (TBS) of Bony plus liner showed significant increasing after 1-month water storage. Conclusion: From the results of this study we can conclude that surface treatment to acrylic base improved tensile bond strength of soft lining material ,and the effect of water storage on bond strength differed with different types of soft lining materials.

Key word: soft liner, bond strength, denture base

INTRODUCTION

Soft lining materials are indicated in a variety of circumstances, but most commonly where the oral mucosa covering the denture–bearing area is locally or generally of inadequate thickness, or where the oral mucosa exhibits a reduced tolerance to the loads applied to it by the denture.\(^1\) In addition, patients with persistent denture--sore mouth are not willing to leave their dentures out of the mouth for any length of time.\(^2\) This can be corrected and the tissues can be returned to health by the use of tissue conditioning materials.\(^3\)
The desirable properties of soft lining materials include: they should be non-irritant, non-toxic, dimensionally stable, have low water absorption and solubility, and permanent resiliency. However regardless of all these desirable properties of a liner, if it does not adhere well to the denture base, the material will not function satisfactorily.\(^4\)\(^5\) Problems with the clinical use of soft denture liners include the loss of softness,\(^6\) colonization by \textit{Candida albicans},\(^7\) plaque and calculus accumulation, porosity and poor tear strength,\(^8\) however, the main problem with soft lining materials in clinical practice is the loss of adhesion at the interface with the denture base resin, which exacerbates most of the above problems.\(^8\)\(^9\)

Surface treatments of acrylic denture base have been found efficient to enhance bonding strength of soft liner to acrylic base like roughening, use of solvents, and use of adhesives.\(^10\)\(^11\)\(^12\)\(^13\)

**MATERIALS AND METHODS**

Three different soft lining materials were used in this study as listed in (Table 1). The acrylic denture base and auxiliary materials used are listed in Table (2).

| Table (1): Types of Tested Soft Lining Materials. |
|-----------------------------------------------|
| **Product** | **Type** | **Manufacturer** | **Class** | **Batch No.** |
| Molloplast- B | Heat- curing silicone based soft denture liner | DETAX Ettlinger, Germany | Type B, class 1 One component + primo adhesive | 040318 |
| GC Reline | Chair side vinyl poly-siloxane tissue toning material | GC Corporation, Tokyo, Japan | Ultra soft two paste + adhesive | 0201156 |
| Bony plus | Chair side acrylic based soft denture liner | Bony F Heiligkveuz 16, Switzerland | Powder and liquid | EB 56 |

| Table (2): Acrylic Denture Base Resins and Auxiliary Materials. |
|-----------------------------------------------|
| **Product** | **Type** | **Manufacturer** | **Class** | **Batch No.** |
| Major base 2 | Heat- curing acrylic denture base | Major prodotti Dentari SPA, Italy | Type I, class 1 Powder and liquid pink color | OJ 3812 |
| Elite model | Gypsum | Zhermack SPA Rovigo, Italy | Type 3 model Dental stone | 2829 |
| ISOL Major | Separating medium | Major prodotti Dentari SPA, Italy | Universal | 3800 |
| Cellophane paper | | | | |

This study was designated to measure the tensile bond strength of two hundred sixty four (264) specimens of acrylic base materials bonded to three different types of soft lining materials. Specimens of each type of soft lining material were randomly divided into different groups according to the type of surface treatment to acrylic base surface and according to the periods of water storage. Specimens of Molloplast- B liner (120 specimens) were randomly divided into five groups of twenty four (24) specimens each according to the type of surface treatment used as follows:

- **Group a:** Molloplast- B liner packed to smooth acrylic surface without any surface treatment (represent control group).
Group b: Molloplast- B liner packed to roughened acrylic surface using acrylic bur no. 032.

Group c: Molloplast- B liner packed to smooth acrylic surface treated with primo adhesive (supplied with Molloplast-B liners according to manufacturer instruction).

Group d: Molloplast- B liner packed to roughened acrylic surface using acrylic bur no. 032 and treated with primo adhesive.

Group e: Molloplast- B liner packed to unpolymerized acrylic cylinder and processed together.

Each group (24 specimens) was stored in an incubator in a distilled water at (37 ± 1) °C temperature for three periods of storage(1 day, 1 month and 4 months).

Ninety six (96) specimens of Bony plus liner bounded to Major denture base material were randomly divided into the following groups (of 24 specimens each) according to type of surface treatment:

Group a: Bony plus liner packed to smooth acrylic surface without any surface treatment (represent control group).

Group b: Bony plus liner packed to roughened acrylic surface using acrylic bur no. 032.

Group c: Bony plus liner packed to smooth acrylic surface treated with Bony plus liner's liquid for 180 seconds.

Group d: Bony plus liner packed to roughened acrylic surface using acrylic bur no. 032 and treated with liner's liquid for 180 seconds.

Each group (24 specimens) was conditioned for three periods of water storage(1 day, 1 week and 1 month).

Forty eight (48) specimens of GC Reline liner were prepared and randomly divided into:

Group a: 24 specimens of GC Reline liner packed to smooth acrylic surface treated with liner's primer (represent control group).

Group b: 24 specimens of GC Reline liner packed to roughened acrylic surface with acrylic bur no. 032 and treated with liner's primer (according to manufacturer's instructions).

Each group (24 specimens) was conditioned the same as specimens of Bony plus liner.

Specimens used in this study are shown in Figure (1).

Split metal mould was used to prepare the acrylic cylinders used by Kazanjii, (14) (Figure 2).

Figure (1): Diagram of Tested Specimen

Figure (2): Split Metal Mould for preparing acrylic cylinder.
Preparation of acrylic cylinder and curing was done according to manufacturer’s instructions. Dental flask with dental stone (Elite, Zhermack SPA, Rovigo, Italy) as investment material was used to prepare mould for the tensile test specimens Figure (3).

Pair of acrylic cylinders was placed in the mould (with its bonded surface either treated or untreated according to the group) and then Molloplast- B liner or Bony plus liner or GC Reline liner paste were placed between them then the flask was pressed and cured according to manufacturer’s instructions for each material used. A universal testing machine (Zweigle, Semiautomatic strength tester, MILANO) was used to measure the failure load of each specimen, at 50 Kg load cell and 5 mm/ min deformation rate. Mode of failure of each failed specimen was examined visually and by digital light microscope (X 10 magnification). Three way Analysis of variance (ANOVA) and Duncan’s multiple range tests were performed in order to compare between groups.

RESULTS

Tensile bond strength (TBS) of three different types of soft lining materials bonded to acrylic denture base material, after different methods of surface treatment, and after storage in distilled water for different periods of time was evaluated. Three way ANOVA (Balanced designs), (Tables 3,4)

Table (3): (ANOVA) of TBS of Molloplast – B Liner Bonded to Major Denture Base for Levels of Surface Treatments, Storage Time and their Interaction

| Source of Variance          | df | Sum of Square | Mean Square | F- value | P - value |
|-----------------------------|----|---------------|-------------|----------|-----------|
| Surface treatment           | 4  | 46.988        | 11.7472     | 115.37   | 0.000*    |
| Storage time                | 2  | 0.1142        | 0.0571      | 0.56     | 0.572     |
| Surface treatment X Storage time | 8  | 3.3098        | 0.4137      | 4.06     | 0.000*    |
| Error                       | 105| 10.6909       | 0.1018      |          |           |
| Total                       | 119| 61.1035       |             |          |           |

* d.f. = degree of freedom., * mean significant difference.
Table (4): (ANOVA) of TBS of Bony plus Liner for Levels of Surface Treatments, Storage Time and their Interaction.

| Source of Variance                  | df | Sum of Square | Mean Square | F- value | P - value |
|-------------------------------------|----|---------------|-------------|----------|-----------|
| Surface treatment                   | 3  | 15.5610       | 5.1870      | 412.96   | 0.000*    |
| Storage time                        | 2  | 2.3574        | 1.1787      | 93.84    | 0.000*    |
| Surface treatment X Storage time    | 6  | 1.2721        | 0.2120      | 16.88    | 0.000*    |
| Error                               | 84 | 1.0551        | 0.0126      |          |           |
| Total                               | 95 | 20.2456       |             |          |           |

- d.f. = degree of freedom, * mean significant difference.

showed that there were significant differences ($P < 0.001$) in mean TBS of Molloplast – B liner and Bony plus liner after different surface treatments (irrespective to storage time). Duncan’s multiple range test (DMRT), (Table 5)

Table (5): (DMRT) of TBS of Molloplast – B Liner Bonded to Major Denture Base after Different Surface Treatment.

| Polymerization | Surface treatment      | N  | Mean (MPa)±SD | DMRT Groups* |
|----------------|------------------------|----|---------------|--------------|
| Polymerized acrylic denture base    | Control                | 24 | 0.9547±0.1929 | C            |
|                                | Primo adhesive         | 24 | 2.3454±0.4121 | A            |
|                                | Roughening             | 24 | 1.3617±0.1658 | B            |
|                                | Roughening + Primo adhesive | 24 | 2.3125±0.3519 | A            |
| Unpolymerized acrylic denture base | Control                | 24 | 0.9500±0.1306 | C            |

DMRT= Duncan’s multiple range test, * = Different letters mean statistically significant difference at $p \leq 0.05$.

showed that there was a significant increasing in mean TBS of groups of Molloplast – B liner after different surface treatments when compared with the control groups. Although roughening of the acrylic surface with bur significantly increased mean TBS of Molloplast – B liner, but the highest improvement in mean TBS was observed after primo adhesive treatment to both smooth and roughened acrylic surface. The same table showed that packing Molloplast – B liner to unpolymerized acrylic resin insignificantly decreased mean TBS when compared with the control group. Duncan’s multiple range test (Table 6).

Table (6): (DMRT) of TBS of Bony plus Liner after Different Surface Treatment.

| Surface treatment      | N   | Mean (MPa)±SD | DMRT Groups* |
|------------------------|-----|---------------|--------------|
| Control                | 24  | 0.5300±0.0352 | B            |
| Liner’s liquid         | 24  | 1.3683±0.0988 | A            |
| Roughening             | 24  | 0.6075±0.0358 | B            |
| Roughening + Liner’s liquid | 24  | 1.3758±0.0466 | A            |

DMRT= Duncan’s multiple range test, * = Different letters mean statistically significant difference at $p \leq 0.05$.

showed that the liner’s liquid treatment to both smooth, and roughened acrylic surfaces significantly increased mean TBS of Bony plus liner when compared with the control group. While roughening of acrylic surface alone had insignificant increasing in mean TBS of Bony plus liner when compared with the control group. Three way ANOVA (Balanced design), (Table 7).
Table (7): (ANOVA) of TBS of GC Reline Liner for Levels of Surface Treatment, Storage Time and their Interaction.

| Source of Variance | df  | Sum of Square | Mean Square | F-value | P-value |
|--------------------|-----|--------------|-------------|---------|---------|
| Surface treatment  | 1   | 0.1397       | 0.1397      | 2.99    | 0.091   |
| Storage time       | 2   | 0.0684       | 0.0342      | 0.73    | 0.487   |
| Surface treatment  |     |              |             |         |         |
| X Storage time     | 2   | 0.9770       | 0.4885      | 10.44   | 0.000*  |
| Error              | 42  | 1.9650       | 0.0467      |         |         |
| Total              | 47  | 3.1502       |             |         |         |

• d.f. = degree of freedom, * mean significant difference.

Showed that roughening of acrylic surface with bur had insignificant effect on mean TBS of GC Reline lining material (irrespective to storage time).

Different periods of water storage had significant effect on TBS of Bony plus liner only, (Table 4), DMRT, (Table 8).

Table (8): (DMRT) for the Effect of Water Storage on Mean TBS of Bony plus Lining Material

| Storage Group | Control groups | Tested groups |
|---------------|----------------|---------------|
|               | N  | *Mean(MPa)±SD | N  | *Mean(MPa)±SD |
| 1 day         | 8  | 0.268±0.0352  | 24 | 0.995±0.1322  |
| 1 week        | 8  | 0.480±0.0616  | 24 | 1.057±0.0988  |
| 1 month       | 8  | 0.841±0.1060  | 24 | 1.298±0.0986  |

• DMRT= Duncan’s multiple range test, * = Different letters mean statistically significant difference at p ≤ 0.05.

Showed that there was significant increase in mean TBS of Bony plus lining material after 1 month water storage in both control groups and tested groups. After 1 week water storage there was an increase in mean TBS but it was in significant. The effect of acrylic surface treatment on mode of failure percentage of all lining materials tested are shown in Table (9).

Table (9): Effects of acrylic surface treatment on mode of failure percentage of all lining material tested.

| Materials    | Mode of Failure Percent for Untreated groups(control) | Mode of Failure Percent for Treated groups |
|--------------|------------------------------------------------------|------------------------------------------|
|              | N  | Adh | Coh | mix | N  | adh | coh | Mix |
| Molloplast-B | 24 | 92  | 4   | 4   | 96 | 2   | 50  | 48  |
| Bony plus    | 24 | 71  | 21  | 8   | 72 | 11  | 42  | 47  |
| GC Reline    | 24 | 63  | 0.00| 37  | 24 | 13  | 33  | 54  |

• adh=adhesive failure, coh=cohesive failure. mix=mixed failure, N=number of samples.

The effect of water storage on mode of failure percentage of all tested materials are shown in Table (10).
Table (10): Effects of water storage on mode of failure percentage of all lining materials tested

| Storage Groups | Types of Lining Materials |
|----------------|---------------------------|
|                | Molloplast-B               | Bony plus | GC Reliner |
|                | N  | adh. | coh. | mix. | N  | adh. | coh. | mix. | N  | adh. | coh. | mix. |
| 1 day          | 40 | 17   | 43   | 40   | 32 | 41   | 34   | 25   | 16 | 0.00 | 31   | 69   |
| 1 week         | _  | _    | _    | _    | 32 | 3    | 47   | 50   | 16 | 44   | 0.00 | 56   |
| 1 month        | 40 | 25   | 40   | 35   | 32 | 3    | 28   | 69   | 16 | 69   | 19   | 12   |
| 4 months       | 40 | 17.5 | 40   | 43   | _  | _    | _    | _    | _  | _    | _    | _    |

• adh=adhesive failure. coh=cohesive failure. mix=mixed failure. N=number of samples.

The effect of water storage on mode of failures percentage of tested groups of Molloplast – B liner were small. The effect of water storage on mode of failures percentage of Bony plus liner for the tested groups showed that cohesive failures percentage increased after 1 week and 1 month water storage, while adhesive and mixed failure percentage decreased. The effect of water storage on mode of failures percentage of GC Reliner liner for the tested groups showed that cohesive failure percentage decreased after 1 week and 1 month water storage, while adhesive failure percentage increased.

DISCUSSION

In the present study roughening acrylic surface with bur significantly improved TBS of Molloplast – B liner (1.3617 MPa) when compared with the control group (0.9547 MPa) as shown in Table (5).

The effect of roughening with bur on TBS of chair side soft lining materials (Bony plus and GC Reline) was insignificant as shown in Tables (6 and 7). Nevertheless, the mode of failures of both materials after surface treatment showed predominant cohesive and mixed mode of failure when compared with the control groups Table (9). These results indicated that the soft lining materials tore before debonding from roughened denture base.

The improvement effect of roughening with bur on tensile bond strength of soft lining materials came in agreement with the results of Kazanjii\textsuperscript{14} who revealed that irregularities of the acrylic surface provided means for mechanical inter-locking of soft lining material in the hard resin.

The results of the present study contradict the results of other researchers.\textsuperscript{(15,16)} The results of the present study, Table (5), showed that the mean TBS of Molloplast – B liner after primo adhesive treatment to both smooth and roughened denture base surface were significantly higher than control group (2.3454 MPa for smooth base; 2.3125 MPa for roughened base). In addition, this type of surface treatment had the highest TBS values among other types of surface treatments. Mode failures of this group of surface treatment also support the results of TBS Table (9). Silicone base soft lining materials have a chemical composition which differs from acrylic resin denture base therefore there is no chemical bonding between these two materials. An adhesive is supplied with silicone – based soft denture liners in order to aid in bonding the liner to the resin denture base. Therefore, the bond strength of silicone base liners depends on the tensile strength of the material and adhesive used. Without this adhesive, silicone denture base liner has little or no chemical adhesion to PMMA resins.\textsuperscript{(17, 18)}

During manipulation with primo adhesive of Molloplast – B liner, it leaves a layer over acrylic surface after drying. Thus forming a tenacious layer which adheres silicone liner to acrylic base. The chemical components of this primo adhesive were not published, but Minami\textsuperscript{12} stated that primo adhesive may consist of an organic solvent and adhesive monomer,
which react with both silicone and resin materials.

In the present study, treating acrylic denture base surface with Bony plus liner's liquid also was suggested to improve the weak TBS of this type of liner to denture base. The result of groups of liner's liquid treatment to both smooth and roughened acrylic surface Table (6) showed significant increase in TBS of Bony plus to PMMA (1.3683 MPa for smooth acrylic and 1.3758 MPa for roughened acrylic) when compared with the control group (0.53 MPa).

There is no previous work studied the effect of lining material's liquid treatment on its bond strength to acrylic base. Bony plus liner's liquid composed of Butyl phthalate, Butyl glycolate, Dibutyl phthalate which are plasticizers dissolved in an ethyl alcohol (as listed by the manufacturer). This improving in TBS of Bony plus liner after liner's liquid treatment could be related to the dissolving effect of an ethyl alcohol to acrylic surface. This dissolving effect forms micro pores which enhances mechanical inter-locking and chemical adhesion between liner and denture base, also promotes penetration of liner material into the denture base. (20)

Packing Molloplast–B liner to un polymerized Major denture base had an insignificant effect on TBS as shown in table (5) (0.9500 MPa for un polymerized and 0.9547 MPa for control), but TBS of Molloplast–B liner to polymerized groups after surface treatment gave a higher bond strength. In spite of that mode of failures percentage showed predominant cohesive and mixed failure. This indicated that packing Molloplast – B liner to un polymerized denture bases had improving effect on bond strength so that the material tore before debonding occurred. These results came in accordance with other researchers. (14,15) This finding suggests the possibility of formation of a simultaneous inter-penetrating network by the molecules of the two materials a cross the interface. Bond strength of Molloplast-B liner was not affected by water storage Table (7), but the mode of failures percentage Table (10) showed shifting toward adhesive failure after water storage. This means that although the effect on TBS was insignificant but there was a decrease in bond strength of GC Reline liner to denture base after water storage. The explanation is that water may percolate directly into the bond site leading to swelling and consequently stress building up at the denture base interface, causing reduction in the bond strength. The indirect effect of water is that it causes changes in the visco elastic properties of the liners. (14,16)

Bony plus lining materials showed a significant increase in TBS after different periods of water storage, Table (8). The explanation to this increase in bond strength after water storage was related to continual polymerization of this material, or due to the release of plasticizer agents to the aqueous environment. As a result of the plasticizer agent solubility, there was less lengthening, and increased rigidity of the material, allowing an increase in the tensile bond strength of the liner. (12, 23, 24)

CONCLUSION

From the results of this study we can drown that surface treatments to acrylic base improved tensile bond strength of all soft lining material tested. water storage has no effect on bond strength of Molloplast-B liner but it decreased bond strength of GC Reline liner and increased bond strength of Bony plus liner.

REFERENCES

1. Wright PS. Composition and properties of soft lining materials for acrylic dentures. J Dent. (1981); 9: 210-223.
2. Garcia LT, Jones JD. Soft liners. Dent Clin North Am. (2004); 48:709-720.
3. Truhlar MR, Shay K, Sohule P. Use of a new assay technique for quantification of antifungal activity of nystatin incorporated in denture liners. J prosthet Dent. (1994) ; 71: 517-524.
4. Hekimoglu C, Anil N. The effect of accelerated aging on the mechanical properties of soft denture lining materials. J Oral Rehabil. (1999); 26: 745-750.
5. Waters MGJ, Jagger RG. Mechanical properties of an experimental denture soft lining material. J Dent. (1999); 27: 197-202.
6. Klingler SM, Lord JL. Effect of common agents on intermediary temporary soft relines materials. J Prosthet Dent. (1973); 30: 749-755.
7. Nikawa H, Jin C, Hamada T, Murata H. Interactions between thermal cycled resilient denture lining materials, salivary and serum pellicles and Candida albicans in vitro, part I: effects on fungal growth. J Oral Rehabil. (2000); 27:41-47.
8. International Standard ISO 10139 – 2. Dentistry soft lining materials for removable dentures, part 2: materials for long term use. 1st ed., Geneva 20. Switzerland. (1999)
9. McCabe JF, Carrik TE, Kamdnara H. Adhesive bond strength and compliancy for denture soft lining materials. Biomaterials. (2002); 23: 1347-1352.
10. Taft RM, Cameron SM, Knudson RC, Runyan DA. The effect of primers and surface characteristics on the adhesion – in peel force of silicone elastomers bonded to resin materials. J Prosthet dent. (1996); 76: 515-518.
11. Hayakawa I, Keh E, Morizawa M, Murakura G, Hirano. A new polyisoprene – based light – curing denture soft lining material. J Dent. (2003); 31: 269-274.
12. Minami H, Suzuki S, Ohashi H, Kurashige H, Tanaka T. Effect of surface treatment on the bonding of an auto polymerizing soft denture liner to a denture base resin. Int J Prosthodont. (2004); 17: 297-301.
13. Sarae YS, Basoglu T, Ceylan GK, Sarae D, Yapici O. Effect of denture base surface pretreatment on micro leakage of a silicone – based resilient liner. J Prosthet Dent. (2004); 92: 283-287.
14. Kazanj MNM. The physical properties of resilient denture lining materials. M.Sc. Thesis, Faculty of Medicine, University of Bristol. (1987)
15. Amin WM, Fletcher AM, Ritchie GM. The nature of the interface between polymethylmethacrylate denture base materials and soft denture liners. J Dent. (1981); 9:336-346.
16. Jagger RG, Al- Athel MS, Jagger DC, Vowles RW. Some variables influencing the bond strength between PMMA and silicone denture lining material. Int J Prosthodont. (2002); 15: 55-58.
17. Pinto JR, Mesquite MF, Henriques GE, Nóbilo MA. Effect of thermo-cycling on bond strength and elasticity of four long-term soft denture liners. J Prosthet Dent. (2002); 88: 516-521.
18. Kulak-Ozkan Y, Sertgöz A, Gedik H. Effect of thermo cycling on tensile bond strength of six silicones – based resilient denture liners. J Prosthet Dent. (2003); 89: 303-310.
19. Al-Omari AW. Evaluation of some mechanical and physical properties of relined acrylic denture base material by using different curing techniques. M.Sc. Thesis, College of Dentistry, University of Mosul. (2005).
20. Arima T, Nikawa H, Hamada T, Harsono T. Composition and effect of denture base resin surface primers for reline acrylic resins. J Prosthet Dent. (1996); 75: 457-464.
21. Aydin AK, Terzioglu H, Akinay AE. Ulubayram K, Hasirci N, Bond strength and failure analysis of lining materials to denture resin. Dent Mater. (1999); 15: 211-218.
22. Pinto JR, Mesquita MF, de Arrudabilo MA, Henriques GE. Evaluation of varying amounts of thermal cycling on bond strength and permanent deformation of two resilient denture liners. J Prosthet Dent. (2004); 92:288-293.
23. Rodrigues Garcia RCM, Léon BLT, Oliveira VMB, Del Bel Cury AA. Effect of a denture cleanser on weight surface roughness, and tensile bond strength of two resilient denture liners. J Prosthet Dent. (2003); 89: 489-494.
24. Léon BLT, Cury AA, Garcia RC. Water sorption, solubility and tensile bond strength of resilient denture lining materials polymerized by different methods after thermal cycling. J Prosthet Dent. (2005); 93: 282-287.