Journal of Applied Dental and Medical Sciences
NLM ID: 101671413 ISSN:2454-2288
Volume 1 Issue 3 October-December 2015

Original Research

An In Vitro Study to Assess the Changes in Hardness and Tensile Bond Strength of Selected Soft Lining Materials, After Long Term Immersion in Denture Cleansers

Anumeha Narwal[1]
[1]*Dept. of Prosthodontics, Punjab Government Dental College, Amritsar, Punjab, India*

ARTICLE INFO

Access this article online :

Keywords:
Soft liners .Denture cleansers .Hardness, Tensile strength.

ABSTRACT

One of the most clinical challenging issues in prosthodontics is hardening and debonding of soft liners from the denture base with time.

Purpose: The purpose of present study was to assess the effect of two denture cleansers with different modes of action on the hardness and tensile bond strength of two autopolymerizing denture liners-one silicone based and one acrylic based bonded to denture base resin.

Materials & Methods:420 test specimens were fabricated. out of which 210 were circular specimens (105 of each resilient liner) and were used for testing hardness. Other 210 fabricated specimens of heat cured PMMA were used for testing tensile bond strength after bonding it with two autopolymerizing resilient liners (105 of each silicone and acrylic based liners). Each group was further divided into seven subgroups of 15 specimens each, one to act as control and six were subjected to immersion in the two denture cleansers for different time intervals of 1 week, one month and six months. Hardness measurements of denture liners specimens (20x4mm) were done using Shore A Durometer and the tensile bond strength measurements of the specimens (10x10x83mm) using Universal Testing Machine.

Results: Statistical analysis showed that immersion in denture cleansing solutions significantly decreased the tensile bond strength of the resilient liners to the denture base resin ($P<0.01$) and increased their hardness ($P<0.01$): and this increase was more in acrylic -based liners.

Conclusion: It was concluded that within the limitations of this study, immersion in denture cleansers increases the hardness and decrease the tensile bond strength of lining materials bonded to denture base resin: irrespective of the type of denture cleanser used.

Introduction

Soft denture liners are applied to the intaglio surface of dentures to achieve a more even force distribution, to reduce localized pressures and to have a cushioning effect between the denture and underlying denture bearing tissues. These properties make resilient liners useful for treating patients with atrophic or resorbed ridges, bony undercuts, bruxism, soreness, knife- edge ridges, congenital or acquired oral defects requiring obturation, xerostomia and dentures opposing natural teeth. Additional applications have emerged in the past few years for patients with postoperative defects requiring obturation, for transitional prosthesis during, the healing period for osseointegration and for the retention in implant-supported overdentures[1].

Denture lining materials have been used in dentistry for more than a century and the earliest soft liners were made from natural rubber. One of the first synthetic resin developed in 1945 as a soft liner was plasticized polyvinyl resin, followed by the introduction of silicones in 1958[2].Contemporary soft lining materials can be

* *Corresponding author.* ***Dr Anumeha Narwal.MDS Prosthodontics, Oral Health Consultant in BKN Multispeciality Hospital,Rohtak. Email-anrd1824@gmail.com Ph: 9315960007***

divided into two groups- silicone based and acrylic based, both are available in autopolymerized or heat polymerized forms. Autopolymerized resilient liner materials allow the clinician to reline a removable denture directly, intraorally. However, it is difficult to produce liner materials of the optimum thickness with the autopolymerized technique. To provide an adequate shock absorption effect, the optimum liner thickness of approximately 2-3mm is required [3,4,5.]

Initial softness of plasticized acrylic liners is due to the large quantity of plasticizer in the liquid[6]. In silicone-based liners, no plasticizer is necessary for the softening effect, because polydimethylsiloxane is a viscous liquid added to an arrangement that can be cross-linked to form a rubber with good elastic properties [6].

During clinical use with time, plasticizers and other components may leach out while water or saliva is absorbed. This may cause alterations in the viscoelastic properties of the resilient liners. Consequently, loss of softness can result in the delivery of greater occlusal forces to the underlying mucosa and increased complaints.

There are several problems associated with the use of soft denture liners including bond failure between liner and the denture base, loss of softness, colonization by Candida albicans, porosity and poor strength.[7]One of the most serious problems with these materials is bond failure between the resilient denture liner and denture base which creates a potential surface for bacterial growth, plaque and calculus formation.

A variety of parameters affect the bond between the resilient lining materials and the denture base, including water absorption, surface primer use, and denture base composition. Several tests have been used to assess the bond strength of soft denture liners such as peel, sheer or tensile tests.[8]However, in vitro tensile test was found to be effective in evaluating the bond strength and in ranking the materials[7].

The increased porosity of denture soft liners in clinical use may lead to the accumulation of plaque and colonization of Candida albicans. To prevent the consequent denture stomatitis; two methods are employed: mechanical plaque control and chemical plaque control. Brushing is not advisable because it can damage the resilient lining [7,9]. The immersion with chemical agents is primarily the preferred method for geriatric patients and for patients with poor motor-nerve capabilities.

Different types of denture cleansers (such as alkaline peroxide solutions, hypochlorite solutions, acidic solutions, disinfectants and enzymatic solutions) with different modes of action have been considered to be an efficacious method to prevent Candida albicans colonization and denture plaque formation.

However, their daily use can also affect the properties such as hardness, colour stability, bond strength and weight changes etc. of both denture acrylic resin and resilient liners. Denture cleansers cause substantial deterioration since they can cause loss of soluble components and plasticizers and as a consequence, denture soft liners can absorb water or saliva which can impact the properties of these materials.

The proper selection of denture cleanser is thus crucial to avoid or minimize any plausible alterations in the properties of resilient liners. The present study was undertaken to examine, compare and assess the effect of two denture cleansers with different modes of action, on the properties of hardness and tensile bond strength of two autopolymerizing resilient liners.

Table 1 :Materials used in the study

Material	Manufacturer	Type	Adhesive	Polymerization
Mollosil	Detax, Germany	Silicone-based soft denture liner	MollosilAdhesive – 03007	Autopolymerization
Permasoft	Dentsply, Austenal USA	Acrylic based soft denture liner	_	Auto polymerization
Trevlon	Dentsply, Austenal USA	Heat cured PMMA denture base resin	_	Heat polymerization

Materials and Method

The present study evaluated the effect of various denture cleansers on the hardness and tensile bond strength of two commercially available autopolymerizing soft denture liner- one silicone based and one acrylic based bonded to denture base resin. The materials used in this study were tabulated in (table l)Two denture cleansers used with different modes of action for immersion of specimens were :

1. Clinsodent powder(containing sodium perborate)
2. VI-Clean liquid(containing sodium hypochlorite)
3. Control group samples were immersed in artificial saliva (Wet mouth).

Two brass dies were used to fabricate specimens for measuring tensile bond strength and hardness. First die (Fig:1) was used to make specimens of PMMA of dimensions 10x 10x40 mm each, with 3mm thick removable brass spacer (for resilient liners), for measuring tensile bond strength. Second die (Fig:2)was used for the fabrication of circular (disc shaped) test specimens of resilient liners of dimensions 20x4mm, for hardness measurements.

A total of 420 specimens of the two autopolymerizing denture liners were fabricated of which 210 test specimens were processed with heat cured polymerizing PMMA for measuring the tensile bond strength. The rest 210 circular specimens (105 specimens of each type of the autopolymerizing liners) were prepared for testing their hardness. Division of 420 specimens into four different groups was done as under:

Group I: 105 circular specimens of autopolymerizing silicone based liners for the measurements of hardness.

GroupII : 105 circular specimens of autopolymerizing acrylic based liners for the measurements of hardness.

Group III: 105 specimens of PMMA with autopolymerizing silicone based liners for the measurements of tensile bond strength.

Group IV: 105 specimens of PMMA with autopolymerizing acrylic based liners for the measurements of tensile bond strength.

Each group was further divided into seven subgroups A, B, C, D. E, F and G of 15 specimens each for immersion

in the two denture cleansers for different time intervals.(Table 2)

For hardness (Group I and II)

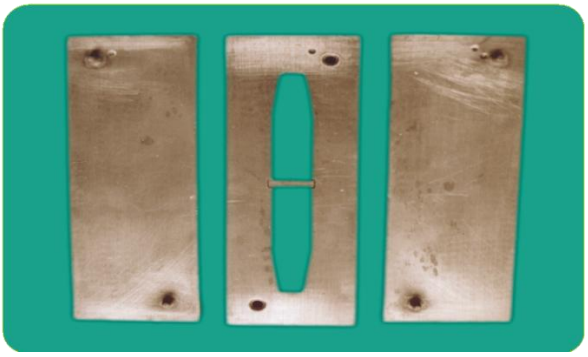

Fig:1Brass die for fabricating tensile strength specimens

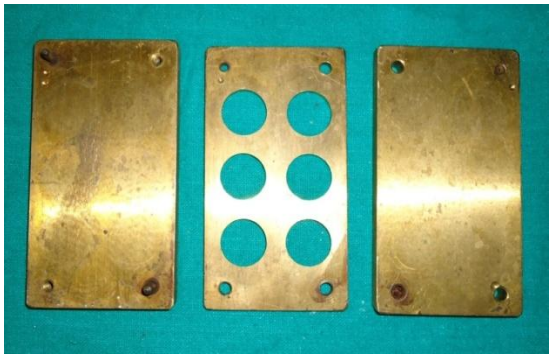

Fig:2 brass die for fabricating hardness specimens

All circular specimens were immersed in the denture cleansing solutions (containing sodium hypochlorite and sodium perborate respectively) according to their subgroups, for given time interval and then hardness values were obtained using Shore A Durometer.

For tensile bond strength measurement (Group III and IV)

All the specimens were immersed in the denture cleansing solution according to subgroups for given time interval and then were deformed in the Universal Testing Machine at the rate of 20mm/min, to determine the maximum tensile load before failure.

Bond strength was calculated as follows:

Bond strength = Maximum load before failure (kg)/ Cross sectional area (cm2)

The readings thus obtained from Shore A Durometer and Universal Testing Machine, were subjected to statistical analysis. One- way ANOVA two-way ANOVA, Three-way ANOVA and Tukey HSD post-hoc tests were adopted to analyze the obtained data.

RESULTS

The mean hardness values obtained are shown in (Fig 3,4) and mean tensile strength values are shown in Fig (5,6).

Mean hardness of the autopolymerizing silicone-based resilient liner (Mollosil), according to the time period of immersion and type of denture cleansers applied, was minimum of control group (23 Shore) and maximum after 6 months immersion in sodium hypochlorite cleanser (29.53 Shore). Mean hardness values of the autopolymerizing acrylic- based resilient liner (Permasoft) according to the time period of immersion and type of denture cleansers applied, was lowest after 1 week immersion in sodium hypochlorite denture cleanser (27.867 Shore) and highest after 6 months immersion in sodium perborate denture cleanser (43.867 Shore). Among the two liners and denture cleansers combination used, highest value of hardness (46 Shore) was observed in acrylic based liner after 6 months storage in sodium perborate denture cleanser and lowest value (22 Shore) was of control group specimen of silicone based liner.

Tensile bond strength of the autopolymerizing silicone-based resilient liner (Mollosil) ,depending upon the time period of immersion and type of denture cleansers used, was found to be maximum for control group (9.275Kg/cm2) and minimum after 6 months of immersion in sodium perborate denture cleanser (5.879 Kg/cm2).Tensile bond strength of auto polymerizing acrylic based resilient liner (Permasoft), depending upon the time period of immersion and type of denture

Table 2: Kind of treatment for groups

Groups	Kind of treatment
IA, IIA, IIIA and IVA	Served as control
IB, IIB, IIIB and IVB	immersed in sodium perborate denture cleanser for 1 week
IC, IIC, IIIC and IVC	immersed in sodium hypochlorite denture cleanser for 1 week
ID, IID, IIID and IVD	immersed in sodium perborate denture cleanser for 1 month
IE, IIE, IIIE and IVE	immersed in sodium hypochlorite denture cleanser for 1 month
IF, IIF, IIIF and IVF	immersed in sodium perborate denture cleanser for 6 months
IG, IIG, IIIG and IVG	immersed in sodium hypochlorite denture cleanser for 6 months

cleansers used ,was found to be highest of control group (10.374 Kg/cm2), and lowest (6.614Kg/cm2) after 6 months immersion in sodium perborate denture cleanser

(5.3kg/cm2) was seen in silicone based liner after 6months storage in sodium hypochlorite denture cleanser and highest value (11.97 kg/cm2) was of control group specimen of acrylic based liner.

Analysis of the tensile strength and hardness values by one way ANOVA have led us to the conclusion that difference in the means of groups was highly significant. Since the number of groups were more than two, comparison between two or more groups were done through Tukey's Multiple Comparison Test. The data was also analysed through three-way ANOVA technique and results are tabulated in(table 3,4).

Immersion in denture cleansing solutions for long time significantly decreased the tensile bond strength of the resilient liners to the denture base resin (P<0.01). The comparison between two cleansers showed non significant(P>0.01) results .

Immersion in denture cleansing solutions for long time significantly increased the hardness of the resilient liners used (P<0.01); and this increase was more in acrylic -based liners. The comparison between two cleansers showed non significant(P>0.0/) results .

.Among the two liners and denture cleanserscombination used, the lowest value of tensile bond strength

DISCUSSION

Proper denture hygiene is always imperative and many patients who wear denture do not have an acceptable

level of hygiene [10]. Therefore, an inclusive range of denture cleansers are provided to develop denture hygiene. Daily usage of denture cleansers can influence the physical properties of acrylic denture bases and soft liners [7].In this study, the effect of two denture cleansers on tensile bond strength and hardness of a soft liner was evaluated. The results showed that tensile bond strength decreased and hardness increased with time for both denture cleansers (Clinsodent and VI Clean). The absorption or loss of soluble constituents of soft liners may cause failure in bond strength between the soft liners and demure acrylic resin of the denture base.

The present study is in agreement with the study conducted by Mese et al [11] which suggested that prolonged exposure to water produced significantly lower bond strength values. In the study by Mese.A [7], the

Table3: Results Through Three-Way Anova Technique-For Tensile Strength Specimens

Source of variation	Degree of freedom	Sum of squares	Mean squares	F-value	P value	Significance level
Liners	**1**	**26.06**	**26.06**	**35.201**	**0.0000**	***
Groups	**6**	**267.30**	**44.55**	**60.172**	**0.0000**	***
-Control vs other groups	1	*126.81*	*489.0*	*22.326*	*0.000*	***
-Among other groups	*5*	*3440.0*	*688.0*	*573.33*	*0.000*	***
Immersion periods	*2*	*3436.0*	*1718.0*	*1275.858*	*0.000*	***
cleansers	*1*	*2.0*	*2.0*	*1.489*	*0.224*	*NS*
Immersion periods vs cleansers interaction	*2*	*2*	*1.0*	*0.697*	*0.499*	*NS*
Liners vs groups interactions	**6**	**883.1**	**147.2**	**117.4**	**0.0000**	***
Residuals	**196**	**246.0**	**1.2**			
Total	**209**	**8654.0**				

Table 4: Results Through Three-Way Anova Technique-For Hardness Specimens

Source of variation	Degree of freedom	Sum of squares	Mean squares	F-value	P value	Significance level
Liners	**1**	**3596.0**	**3596.0**	**2868.2**	**0.0000**	***
Groups	**6**	**3928.9**	**654.8**	**522.4**	**0.0000**	***
-Control vs other groups	1	*489.0*	*489.0*	*22.326*	*0.000*	***
-Among other groups:	*5*	*3440.0*	*688.0*	*573.33*	*0.000*	***
Immersion periods	*2*	*3436.0*	*1718.0*	*1275.858*	*0.000*	***
cleansers	*1*	*2.0*	*2.0*	*1.489*	*0.224*	*NS*
Immersion periods vs cleansers interaction	*2*	*2*	*1.0*	*0.697*	*0.499*	*NS*
Liners vs groups interactions	**6**	**883.1**	**147.2**	**117.4**	**0.0000**	***
Residuals	**196**	**246.0**	**1.2**			
Total	**209**	**8654.0**				

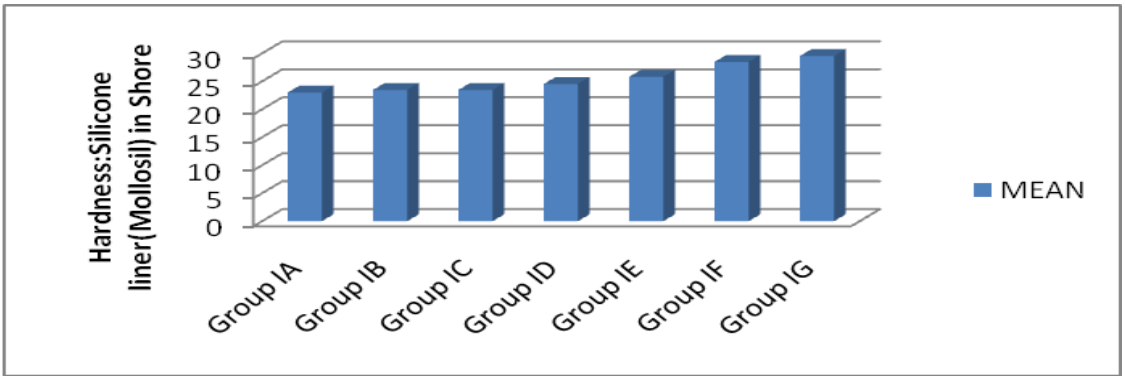

Fig:3 Mean hardness values of Mollosil

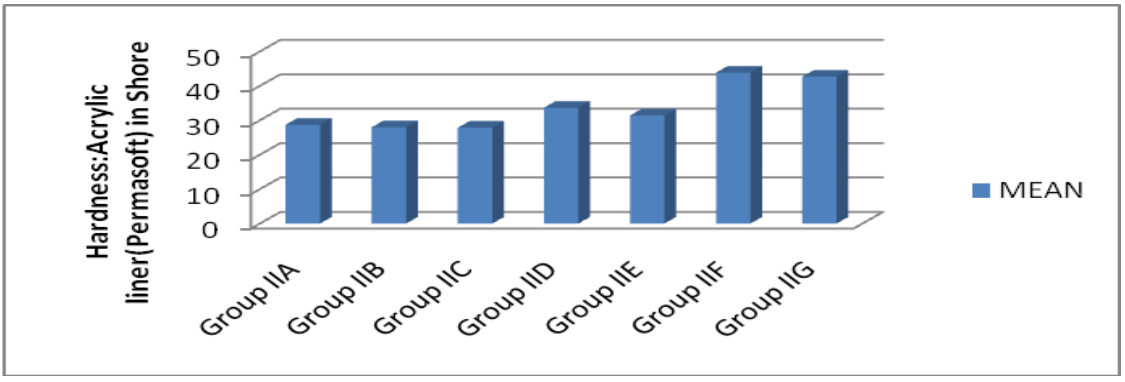

Fig:4 Mean hardness values of Permasoft

comparison between the tensile bond strength of liners in Polident (sodium perborate containing denture cleanser) and water immersion was done.The results showed decreased in the tensile bond strength of the four studied soft liners. These results depict the picture of our present study results where two types of denture cleansers with different modes of action were used. Both the cleansers solutions (sodium perborate) & (sodium hypochlorite) had decreased the tensile bond strength of two different types of liners (one silicone based and one acrylic based) with increase in the immersion period in a similar pattern irrespective of the type of cleanser used. These results were analysed through three way ANOVA technique, where the comparison among different groups was done (Table3). The comparison between two cleansers showed statistically non significant difference ($p>0.05$); whereas the comparison between the different time periods showed statistically highly significant difference ($p<0.01$). Study conducted by Al-Athel et al [12]and by Emmer et al [13] also supports the fact that longer immersion of specimens in water leads to a significant reduction in tensile bond strength. Hardness testing has been done in present study to investigate the effect of two denture cleansers on the hardness of two autopolymerizing (one silicone and one acrylic based liner), It was observed that immersion in denture cleansers leads to an increase in hardness values of two resilient liners. The increase in hardness can be attributed

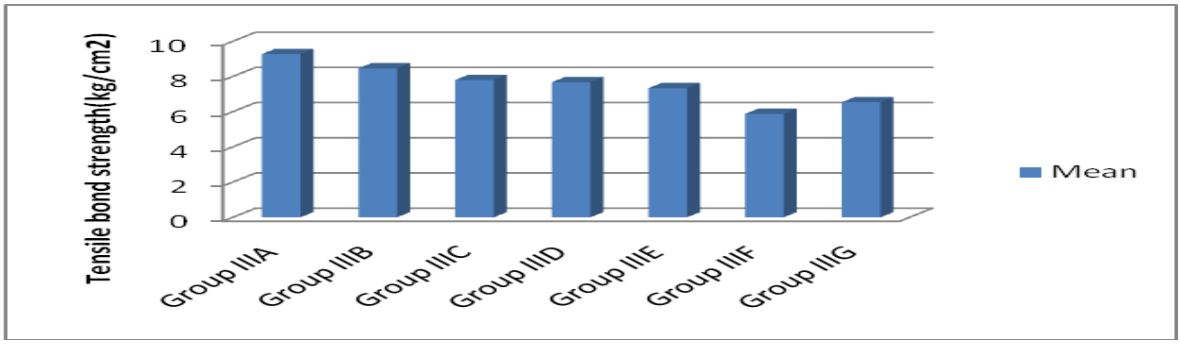

Fig:5 Mean tensile strength values of Mollosil

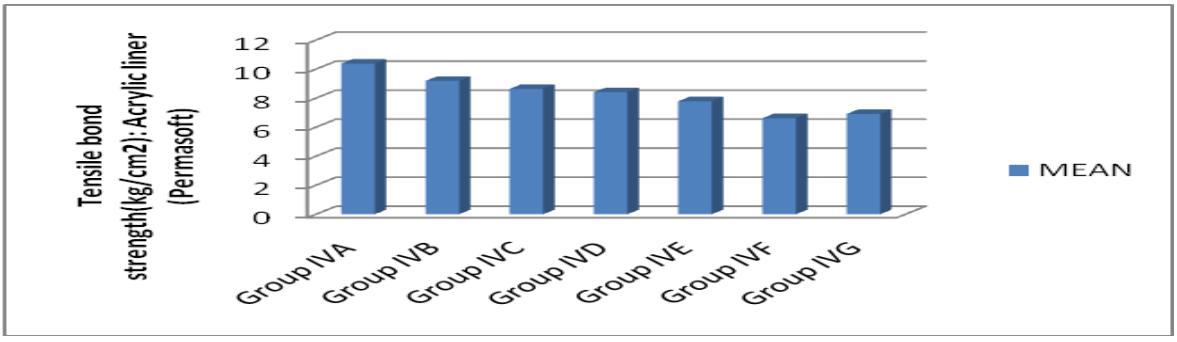

Fig:6 Mean tensile strength values of permasoft

to the loss of plasticizers and liquid percolation or absorption by the liners on long term storage in denture cleanser solutions. This increase in hardness can leads to the loss of elasticity and cushioning effect of liners and thus deteriorates its properties. The present study is in agreement with the study conducted by Pisani et al [14]where increase in mean hardness values of two autopolymerizing silicone based liners(Elite soft and Mucopren soft) was observed after storage in water,1% sodium hypochlorite and Ricinus communis solution(denture cleanser) for 7, 15 and 183 days. Storage of soft liners in denture cleansers leads to an increase in their hardness was confirmed in the study by Bro'zeljt et al [15] where four soft liners : two acrylic based(Vertex Soft &Villacryl Soft) and two silicone based (Molloplast-B &Mollosil) were immersed in solutions of : 2% sodium hypochlorite, 2% aqueous chlorhexidinegluconate, sodium perborate containing tablets & 3% aqueous hydrogen peroxide.

The increase was more in case of acrylic liners due to the loss of their plasticizer component which maintains their elasticity. These findings are in favour of the present study, where more increase in hardness was observed in case of acrylic based liner (Permasoft) as compared to silicone based liner (Mollosil).Our present study also supports the study by Parr et al [16] &Mese et al [4], Ma'helms-. Segundo et at [17] where increase in hardness values of soft liners were observed with increase in immersion time.

Hence, the results of our present study showed that immersion in denture cleansers increases the hardness and decrease the tensile bond strength of two autopolymerizing (silicone based and acrylic based) lining materials bonded to denture base resin. Among the two liners and denture cleansers combination used, the

lowest value of tensile bond strength (5.3kg/cm2) was seen in silicone based liner after 6 months storage in sodium hypochlorite denture cleanser and highest value of hardness(46 Shore) was observed in acrylic based liner after 6 months storage in sodium perborate denture cleanser. Our statistical analysis showed that variations in properties observed were irrespective of type of denture cleanser used. Among the two liners, increase in hardness was more in acrylic based liners as compared to silicone based liners. There could be variations in the measured mean values and can be attributed to the lining material, denture cleansers and denture base resin manufactured by different companies. However, as only two types of resilient liners were used in the study, further investigations are required to analyse the effect of denture cleansers on the bond strength of other available silicone-based and acrylic-based resilient liners. The mode of bond strength evaluation in the present study was under tensile stresses only; hence further studies should be carried out to determine the bond strength after immersion in various denture cleansers under different types of stresses.

Because it is not possible to completely simulate clinical conditions and reproduce the oral environment in the laboratory, so clinical investigations are also required to be carried out before reaching the final conclusion.

REFERENCES

1. **Pavan, S, Filho, JNA, Santos, PHD, Nogueira, SS &Batista, AUD(2007),** 'Effects of disinfection treatments on the hardness of soft denture liner materials.' *J Prosthodont* 16; 2:101-106.
2. **El-Hadary, A &Drummond, JL (2000),** 'Comparative study of water sorption, solubility and tensile bond strength of two soft lining materials.' *J Prosthet Dent* 83;3:356-361.
3. **Kazanji, MNM & Watkinson, AC(1988),** **'**Influence of thickness, boxing and storage on the softness of resilient denture lining materials'. *J Prosthet Dent* 59; 6: 677-80.
4. **Mese, A & Guzel, KG(2008),** 'Effect of storage duration on the hardness and tensile bond strength of silicone and acrylic resin-based resilient denture liners to a processed denture base acrylic resin.' *J Prosthet Dent,*99; 2:153-159.
5. **Yanikogtlu, N & Denizoglu, S (2006), '**The effect of different solutions on the bond strength of soft lining materials to acrylic resin.' *Dent Mater J* 25;1:39-44.
6. **Hermann, C, Mesiquita, MF, Consani, RLX & Henriques, GEP(2008),** 'The effect of aging by thermal cycling and mechanical brushing on resilient denture liner hardness and roughness.' *J Prosthodont,* 17;318-322.
7. **Mese, A 2006,** 'Bond strength of soft denture liners following immersion of denture cleanser.' *Biotechnol. & Biotechnol.Eq.*.20;3:184-191.
8. **AL-Athel, MS & Jagger, RG (1996),** 'Effect of test method on the bond strength of a silicone resilient denture lining material.' *J Prosthet Dent,*76;5:535-540.
9. **Farzin, M, Bahrani, F & Adelpour, E (2013),** 'Comparison of the effect of two denture cleansers on tensile bond strength of a denture liner' *J Dent Shiraz Uni Med Sci,* 14;3:130-135
10. **Dootz, ER, Koran, A & Craig, RG(1992),** 'Comparison of the physical properties of 11 soft denture liners.' *J Prosthet Dent* 6;5:707-712.

11. **Mese, A, Guzel, KG , Uysal, E (2005),** 'Effect of storage duration on tensile bond strength of acrylic or silicone- based soft denture liners to a processed denture base polymer' *Acta Odontol Scand* 63;31-35.

12. **AL-Athel, M, Jagger, R & Jagger, D(2002),** 'Effect of aging on the bond strength of a permanent denture soft lining material.' *J Oral Rehabil,* 29; 992-996.

13. **Emmer, TJ Jr, Emmer, TJ Sr, Vaidynathan, J & Vaidynathan, TK (1995),** 'Bond strength of permanent soft denture liners bonded to the denture base.' *J Prosthet Dent*74;6:595-601.

14. **Pisani, MX, Lovato da Silva, CH, Paranhos, HFO, Souza, RF & Macedo, AP(2012),** 'evaluation of experimental cleanser solution of Ricinus communis: effect on soft denture liners properties.' *Gerodontology,* 29; e179-e185.

15. **Bro˙zek, R, Koczorowski, R, Rogalewicz, R, Voelkel, A, Czarnecka, B & Nicholson, JW (2011),** 'Effect of denture cleansers on chemical and mechanical behaviour of selected soft lining materials' *Dent Mater J;* 27:281-290.

16. **Parr, GR & Rueggeberg, FA(2002),** 'In vitro hardness ,water sorption and resin solubility of laboratory processed and autopolymerized long term resilient denture liners over one year of water storage. *J Prosthet Dent;* 88;2:139-144.

17. **Malheiros-Segundo, AL, Pisani, MX, Paranhos, HFO, DeSouza, RF & Silva-Lovato, CH(2008),** 'Effect of a denture cleanser on hardness, roughness and tensile bond strength of denture liners.' *Braz J Oral Sci.*7;26:1596-1600.

How to cite this article: Narwal A. An In Vitro Study to Assess the Changes in Hardness and Tensile Bond Strength of Selected Soft Lining Materials, After Long Term Immersion in Denture Cleansers. JOADMS 2015;1(3):33-42.

Source of Support: Nil, Conflict of Interest: None declared