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*International Journal of Current Research*
*Vol. 9, Issue, 09, pp.57099-57102, September, 2017*

**INTERNATIONAL JOURNAL OF CURRENT RESEARCH**

**ISSN: 0975-833X**

## RESEARCH ARTICLE

# EFFECT OF TWO DENTURE CLEANSERS ON TENSILE BOND STRENGTH OF A PERMANENT RESILIENT DENTURE LINER BONDED TO A CONVENTIONAL HEAT POLYMERIZED DENTURE BASE RESIN

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**ARTICLE INFO**

*Article History:*
Received 06th June, 2017
Received in revised form
25th July, 2017
Accepted 19th August, 2017
Published online 29th September, 2017

*Key words:*

Denture cleanser,
Enzymatic denture cleanser,
Sodium perborate denture cleanser,
Tensile bond strength,
Resilient liners.

**ABSTRACT**

**Aim:** To study the effect of enzymatic and sodium perborate denture cleansers on tensile bond strength between permanent resilient liner and heat polymerized denture base immersed in different durations of immersion solutions.

**Materials and Methods:** Sixty three samples with the resilient denture liner sandwiched between two polymerized PMMA blocks were divided into three groups A, B and C with 21 samples in each subgroup. All samples were stored in artificial saliva in an incubator at $37^0$C for 15 days. They were then immersed in distilled water (Group A-Control group), enzymatic (Group B-Test group) and sodium perborate denture cleanser (Group C-Test group) for 8 hours once a day and repeated for fifteen days. Tensile bond strength values were evaluated using universal testing machine on 1st, 7th and 15th day. The type of bond failure was assessed using a stereomicroscope. The data was statistically analyzed using one way ANOVA (F-Test), Dunnett D test and Student's paired t test.

**Results:** Group A, B and C showed maximum tensile strength on 14th, 7th and 1st day respectively. Group A and B showed adhesive type of bond failure. Group C showed both adhesive and cohesive types of bond failure. The enzymatic denture cleanser showed more tensile bond strength compared to sodium perborate denture cleanser.

**Conclusion:** This study demonstrated that there were significant differences among the samples for different types and durations of immersion solutions which are due to leaching out of plasticizers from resilient liner and composition of the different immersion solutions.



**Citation: Rene Kuriakose, Godbole, S. R. and Angel Mary Joseph, 2017.** "Effect of two denture cleansers on tensile bond strength of a permanent resilient denture liner bonded to a conventional heat polymerized denture base resin", *International Journal of Current Research*, 9, (09), 57099-57102.

## INTRODUCTION

The retention of a prosthetic device is a cardinal factor in the long term success of the prosthetic treatment. Both biological supporting tissues and materials used in complete denture fabrication are susceptible to time-dependent changes (Zarb *et al*., 2003; Atwood, 1971). The resilient denture liner which acts as a permanent soft cushion on the intaglio surface of the denture is an effective alternative for patients who are unable to tolerate a hard denture base. Resilient liners have exhibited increased porosity as plasticizers leaches out which leads to accumulation of plaque and oral microbial flora that includes bacteria, viruses and fungi like Candida albicans. Therefore as the saying goes "prevention is better than cure", highlights the importance of oral and denture hygiene protocol (Cawson, 1963). Denture hygiene may be compromised due to limitations of the denture base material and lack of manual dexterity of denture wearers. Therefore, chemical plaque control is the method of choice for geriatric patients, done by soaking in denture cleansers to prevent denture stomatitis. The use of available chemical denture cleansers for complete dentures remains controversial because they might alter the roughness, hardness and color of the resilient liners. Hence, the type of denture cleanser and resilient liner used in dental prosthesis influence the clinical outcome of the prosthesis (Renata *et al*., 2003). The aim of this study is to evaluate and compare the tensile bond strength of heat-polymerized resilient denture liners when immersed in enzymatic and sodium perborate denture cleanser. This study also assesses the variation in tensile bond strength of a permanent resilient denture liner at different time intervals immersed in various solutions.

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## MATERIALS AND METHODS

Brass Dies measuring 40 mm x 10 mm x 10 mm and Brass Spacers measuring 3 mm x 10 mm x 10 mm in length, width and height respectively (Fig.1) were invested in dimensionally stable flexible silicone rubber in a conventional denture flask and the mold were prepared (Fig. 2 a). Heat cure resin polymer and monomer (Lucitone 550, Dentsply, India) were proportioned in 3:1 ratio and mixed in porcelain jar. The resin is packed in dough stage into the mould with the brass spacer between (Fig. 2 b). The flask was placed in digitally programmed acrylizer (Apex, India) at $72^0$C for 120 minutes followed by bench cooling for 1 hour. One hundred twenty six blocks of the heat cured acrylic resin samples were prepared (Fig. 2 c). After this process two polymerized heat cured acrylic resin blocks were removed from the flask, trimmed and sandpapered in the area where resilient liners are to be bonded. The brass spacers were then removed from the flask. These polymerized heat cured acrylic resin blocks were replaced in the mold and heat resilient denture liner material was packed into the space left by the brass spacer. The flask was then placed in standard flask press under pressure of 2500 Psi using Hydropress (Sirio Dental, Italy) for 45 minutes and placed in the digitally controlled acrylizer unit for 120 minutes at $72^0$C, followed by 30 minutes at $100^0$C and then polymerized. The blocks were bonded by 3 mm thick layer of the resilient lining material (Vertex Soft, Zeist, Canada) which was sandwiched between two acrylic resin block (Fig.2 d).Consequently, preparation of 63 specimens measuring 83mm in total length and with a cross-sectional area of 10 x10 mm were made. All specimens were stored in artificial saliva in an incubator (Yorko, India) at $37^0$C for 15 days. Artificial saliva was prepared by mixing 0.220 g / L of calcium chloride, 1.07 g / L of sodium phosphate, 1.68 g / L of sodium bicarbonate and 2 g / L of sodium azide in 1 litre of distilled water. The 63 samples were divided into three groups A, B and C with 21 samples in each subgroup. Group A was the control group in which the samples were immersed in distilled water. Group B and C were the test groups in which the samples were immersed in enzymatic (Polident, Block drug co., USA) and sodium perborate (Clinsodent, ICPA Ltd, India) denture cleanser respectively (Fig.3). After the artificial saliva storage, all groups of samples were immersed in the respective solutions for 8 hours once a day and this process was repeated for fifteen days. All the solutions were changed daily for fifteen days. After the initial artificial saliva storage, tensile bond strength values were evaluated using universal testing machine (Instron 3365, UK) on the 1st, 7th and 15th day at a crosshead speed of 5mm/ min (Fig. 4). The tensile load applied was recorded in Newton (N). The type of bond failure was also assessed using a stereomicroscope (Stemi DV4, Zeiss) at original magnification 8X through transmitted light. The data was statistically analyzed using One way ANOVA (F-Test), Dunnett D test and Student's paired t test.

## RESULTS

Group A showed maximum tensile strength on 14 th day with an adhesive type of bond failure. Group B showed maximum tensile strength on 7 th day with adhesive type of bond failure. Group C showed the maximum tensile strength on 1st day which then decreased and it showed both adhesive and cohesive types of bond failure (Table 1 and Fig.5 a, b, c). The enzymatic denture cleanser showed more tensile bond strength compared to sodium perborate denture cleanser (Fig.6).

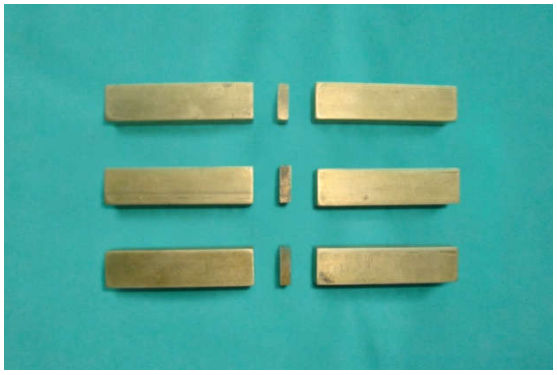

**Fig. 1. Brass dies and Spacers**

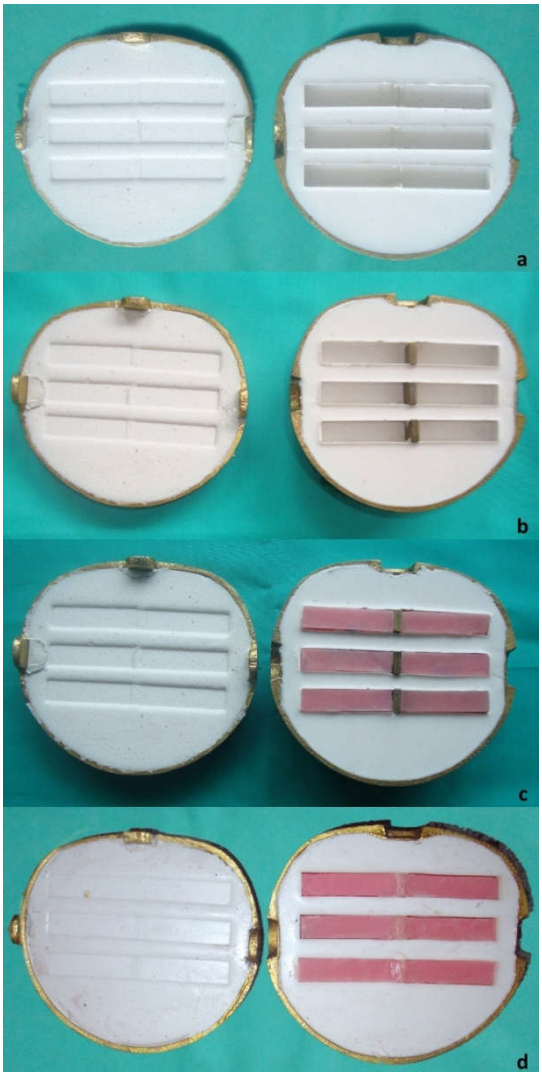


**Fig. 2. Sample showing resilient denture liner sandwiched between two heat polymerized denture base resin blocks**


**Fig. 3. Sample groups immersed in the respective solutions**

**Fig. 4. Tensile bond strength measurement using universal testing machine**

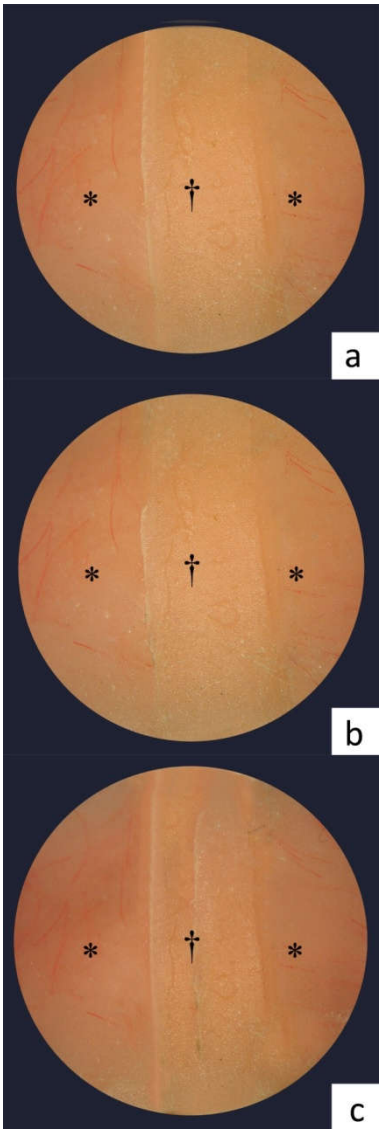


**Fig. 5. Stereomicroscopic examination of bond failure**
*** Heat polymerized denture base resin**
**† Permanent resilient liner**
**a-Group A sample showing adhesive failure**
**b-Group B sample showing adhesive failure**
**c-Group C sample showing adhesive and cohesive failure**

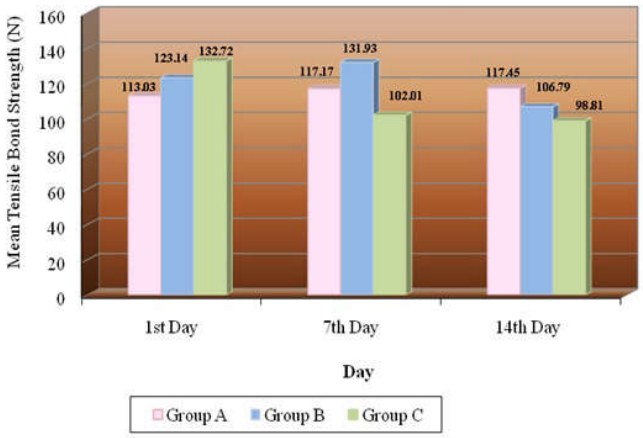


**Fig. 6. Comparison of tensile bond strength at 1st, 7th and 14th day in group A, group B and group C**

**Table 1. The mean values of tensile bond strength of permanent resilient liner bonded to a heat polymerized denture base resin when immersed in different solutions and time intervals**

| Day | Group A Distilled water (CONTROL) Tensile Load (N) | Group B Enzymatic Denture Cleanser (TEST) Tensile Load (N) | Group C Sodium Perborate Denture Cleanser (TEST) Tensile Load (N) |
|---|---|---|---|
| 1 | 114.03 | 123.14 | 132.75 |
| 7 | 117.17 | 131.90 | 102.01 |
| 14 | 117.45 | 106.79 | 98.81 |

## DISCUSSION

The combination of denture cleanser and resilient liner and the material used for denture construction influence the clinical outcome of a removable dental prosthesis (Michman and Seifert, 1961). The tensile bond strengths of soft denture liners to the denture base resin are low with an increase in plasticizer content. Limitations of the resilient liners are loss of resiliency, color alterations and porosity due to leaching out of the plasticizers and other components when immersed in denture cleansers. The loss of plasticizers can alter the bonding surfaces and the viscoelastic properties of the resilient liners. This bond failure creates a potential surface for bacterial growth, plaque accumulation and calculus formation. Effective prevention and control of healthcare associated infections has to be incorporated and applied consistently in everyday practice. Dentures containing food debris, tartar and stain cause tissue response and allow multiplication of microbial flora which may serve as reservoirs for disseminated systemic infections with gastrointestinal and pleuropulmonary involvement (Gornitsky *et al*., 2002). Therefore, chemical plaque control is the method of denture hygiene for geriatric patients especially those lacking manual dexterity which is done by soaking in denture cleansers to prevent denture stomatitis (Zarb *et al*., 2012). The mechanism of action of enzymatic denture cleanser is by the proteolytic enzymes breaking down macromolecules of glycoprotein, mucoprotien and mucopolysacchride found in denture plaque into less adhesive small units (Odman, 1992; Tamamoto *et al*., 1985; Minagi *et al*., 1987). Sodium perborate denture cleanser is an alkaline solution of hydrogen peroxide which liberate bubbles of oxygen exerting a mechanical cleaning effect on the dentures (Langwell, 1955). The effect of denture cleansers on soft denture lining materials was evaluated in previous studies. It was concluded that clinicians should choose denture cleansers by taking into account the

microbiological properties of the denture cleansers and material aspects such as the compatibility of denture cleanser with soft liners (Nikawa *et al*., 1994).

The results of this study demonstrated significant differences among the samples for different solutions and durations of immersion which may be due to leaching out of plasticizers from resilient liner and composition of the different immersion solutions. The samples immersed in distilled water (Group A) showed increased bonding with storage and maximum strength on 14$^{th}$ day. The samples immersed in enzymatic denture cleanser (Group B) showed maximum tensile strength on 7$^{th}$ day. The samples immersed in sodium perborate denture cleanser (Group C) showed the maximum tensile strength on 1$^{st}$ day which then decreased during 7$^{th}$ and 14$^{th}$ day. The enzymatic denture cleanser showed more tensile bond strength compared to sodium perborate denture cleanser. Initially both the denture cleansers showed increase in tensile bond strength which gradually decreased over time. The samples immersed in the denture cleanser showed the loss of soluble component such as plasticizer leaving empty spaces or bubbles. This resulted in an initial roughness of the resilient liner. With time, these bubbles increased in size resulting in craters and showed increase in bond strength. These crater boundaries probably diminish with time and become smooth which may decrease the tensile bond strength (Guang *et al*., 2003). The bond failure is mainly of 2 types-adhesive and cohesive bond failures. Previous studies reported that prolonged exposure to solutions significantly increased the failure strength, introduced brittle behavior to the liner, and changed the mode of failure more toward adhesive failure (Emmer *et al*., 1995). Some critical factors must be taken into consideration while selecting the denture cleanser. An efficient denture cleanser should be selected which does not alter the physical and chemical properties of the resilient liner. The tensile bond strength should be sufficiently high so as to ensure a durable bond with the denture base resin. The duration of immersion of the denture in the denture cleansing solution is also an important factor while selecting the denture cleanser (Michael *et al*., 1990).

## Conclusion

This study demonstrated that there were significant differences among the samples for different types and durations of immersion solutions which are due to leaching out of plasticizers from resilient liner and composition of the different immersion solutions.

Within the scope and limitations of the study the following conclusions were derived.

1. Tensile bond strength of permanent resilient liner with heat polymerized denture base resin decreased with longer period of immersion both in enzymatic and sodium perborate denture cleanser.
2. Distilled water showed increase in tensile bond strength of permanent resilient liner with heat polymerized denture base resin with longer period of storage.
3. Tensile bond strength of permanent resilient liner with heat polymerized denture base resin when immersed in enzymatic denture cleanser for longer period of time was more as compared to sodium perborate denture cleanser.
4. Permanent resilient denture liner bonded with heat polymerized denture base resin when immersed in enzymatic and sodium perborate denture cleanser at different time interval revealed that with longer period of storage tensile bond strength were decreased whereas distilled water did not show much variation and bond strength was increased with longer period of storage.

**Acknowledgement**

We would like to acknowledge the technical support rendered by Jawaharlal Nehru Aluminium Research Development and Design Centre, Nagpur and the Department of Prosthodontics, Sharad Pawar Dental College, Maharashtra for the successful completion of this study.

**Conflict of interest-**None

**Sources of funding-**Nil

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