



EVALUATE AND COMPARE THE EFFECT OF DENTURE CLEANSERS ON TENSILE BOND STRENGTH AND HARDNESS OF SILICONE BASED RESILIENT LINERS - AN IN VITRO STUDY

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ABSTRACT

Objectives: The objectives of this study is to determine the effect of two popular denture cleansers (Clinsodent® & Secure®) on tensile bond strength and hardness of two commonly used silicone based resilient liner (Ufi gel P™ & GC reline soft™), during the period of 6 months storage duration. **Methodology:** For tensile bond strength testing 120 rectangular specimens of both Ufi gel P™ and GC reline soft™ were fabricated with standardized brass flask. Two acrylic blocks were joint with the respective silicone liner material of thickness 3mm x 10mm x 10mm. For hardness 120 cylindrical specimens (20mm x 12mm) of both liner were fabricated from standardized brass flask. All the specimens were stored in water (control), Clinsodent, Secure denture cleansers for a period of 24 hours and 180 days. Evaluation of tensile bond strength done by Univeral testing machine and hardness by shore A durometer after first day and 180 days. All the data were statistically analyzed using paired student t test, one way analysis of variance (ANOVA), Post Hoc test. **Results:** There is a significant reduction in tensile bond strength and increase in shore A hardness of Ufi gel P™ and GC reline Soft specimen stored in Secure denture cleanser for a period of 180 days compared to first day. There was insignificant effect of clinsodent and water on tensile bond strength and hardness of the liner. **Conclusion:** Soft liners stored in cleansing solutions and water did not show much significant variation in mechanical property. Hence it is advisable to use cleansers for better anti microbial property. Ufi gel P™ was proved to be a better material than GC reline soft™ liner with minimal variation.

KEYWORDS: Silicone liner, denture cleansers, tensile bond strength, hardness.

INTRODUCTION

Soft resilient denture liners have a key role in modern removable prosthodontics because of their capability of preventing and restoring health to inflamed and distorted mucosa. They act as a cushion for the denture bearing mucosa leads to absorption and redistribution of forces transmitted to the stress bearing areas of the edentulous ridges. Kawano et al evaluated the cushioning effect of soft denture liners, indicating that a soft liner reduced the impact force during function.^[1]

Soft lining materials is defined as soft compliant, viscoelastic materials which may be applied to the fitting surface of a denture for the purpose of reducing and more evenly distributing occlusal loadings on the underlying mucosal tissues.^[2] One of the first synthetic resins used as a resilient liner, a plasticized polyvinyl resin, was developed in 1945. Silicone based materials were introduced in 1958.^[3] Resilient liners can be divided into 2 groups. Silicone based & acrylic resin

based. They are available in two forms; Self cure / Room temperature vulcanizing (RTV) silicones and Heat temperature vulcanizing (HTV) silicones. The optimum thickness has been reported as approximately 2.5 to 3 mm which is needed to provide good shock absorption.^[2] Acrylic resin based resilient liner materials generally consist of polymers along with a liquid containing methacrylate monomer and plasticizers (ethyl alcohol and/or phthalate). Silicone based resilient liner materials are similar in composition to silicone type impression materials, as they are dimethylsiloxane polymers. Polydimethyl siloxane is a viscous liquid that can be cross linked to form an elastic rubber. One of the most serious problems with these materials is loss of resiliency and bond failure between the resilient denture liner and denture base. Bond failure creates a potential area for growth, plaque and calculus formation.^[4] All other favorable properties of a denture liner will be non significant in the absence of a good bond to the denture base material. There are two types of cleansing

methods, mechanical plaque control and chemical plaque control Brushing is probably not advisable because it can damage the resilient lining. The immersion with chemical agents is primarily the preferred method for geriatric patients and for patients with poor motor nerve capabilities. Although chemical cleansing has been considered an effective method to prevent *C. albicans* invasion and denture biofilm formation.^[5] The chemical solutions used for denture cleansing can be divided based on their chemical components such as alkaline peroxide solutions; hypochlorite solutions, acidic solutions, disinfectants, and enzymatic solution that are more effective in precluding microbial invasion and plaque accumulation. This study was conducted to evaluate changes in tensile bond strength and hardness of two resilient liner when immersed in two denture cleansers on first day and 180 days.

MATERIALS AND METHODS

- 1) Ufi Gel PTM (Auto polymerized silicone liners ,VOCO, Germany) . FIG 1
- 2) GC RelineTM soft (Auto polymerized silicone liners, GC Dental Products corp., Japan.) .FIG 2
- 3) DPITMHeat cure (Heat polymerizing poly methyl meth acrylate acrylic resin and Monomer Dental Products of India, Ltd).
- 4) Clinsodent[®] denture cleanser tablet (Alkaline peroxide ICPA) .FIG 3
- 5) Secure[®] denture cleanser tablet (Alkaline Peroxide, SECURE).FIG 3
- 6) Water (control) and Rectangular containers.
- 7) Bioline[®] Petroleum jelly (Biopharm Laboratories) .

ARMAMENTARIUM

- 1) Standardized 3 piece brass mould (83mm x 10mm x 10mm with a brass spacer of 3mm) for fabrication of tensile bond strength specimen. FIG 4
- 2) Standardized 3 piece brass mould (20mm x 12 mm) for fabrication of hardness specimen. FIG 5
- 3) Universal testing machine (Instron 3365, Instron Corp., Canton, Mass).
- 4) Shore A Durometer.
- 5) Micro motor hand piece (Marathon), 240 Grit silicone carbide paper.
- 6) UnidentTM Acryliser (Unident Instrument India PVT Ltd.)
- 7) Hydraulic Press (Sirio P400) .
- 8) Glass slab ,mixing pad, spatula Scissors and B P knife.
- 9) Auto mix gun.
- 10) Silicone acrylic mixing jar.
- 11) Dental clamp.

FOR TENSILE BOND STRENGTH

In this study, 120 specimens of each liners (60 specimens of Ufi gel P and 60 specimens GC reline soft) were prepared. Tensile bond strength testing was done in Universal Testing machine (Instron model no: 3365)

PREPARATION OF TENSILE BOND STRENGTH SPECIMEN

A) PREPARATION OF STANDARDIZED BRASS FLASK

For conducting this study, acrylic blocks of dimension 40 x 10 x 10 mm (L x W x H) were to be prepared. The dimension of the acrylic blocks were standardized by using a brass mould. This brass mould which comprises of three pieces, upper, middle and lower parts. These three parts can be assembled and secured together using four screws on each corner of the brass mould . Middle part which contained mould space of 83mm x 10mm x 10 mm (Lx WxH). This brass spacer divides mould space into two equal spaces of 40 x10 x10mm dimension.. This customized mould helped in fabrication of 2 heat cured acrylic block at a time.

B) PREPARATION OF HEAT CURED ACRYLIC BLOCK

Study requires 240 heat cured acrylic blocks of dimension 40 x 10 x 10mm Preparation of acrylic blocks was done using a standardized brass mould. Acrylic resin (DPI Heat Cure^[TM] pink LTD.) was mixed acrylic mixing jar and packed into mould space Curing was done at 74⁰c for 2 hours followed by 100⁰c for 1 hour. (FIG 6)

C) PREPARATION OF SOFT LINER SPECIMEN

The brass mould is now set to receive the soft liners. The acrylic blocks are positioned in the mould space, the brass spacer of dimension 3x14x10 mm is now removed. The area to be bonded was thoroughly air dried for 1 minute. Adhesive was applied to the prepared surfaces of two acrylic block and wait for 3 minute. Soft liners were manipulated according to manufacturer's instruction, it was packed into the standardized 3mm x 14mm x 10mm space between the two acrylic blocks. The upper part of flask was placed and tightened with screws. Flask was left for 10 minutes in room temperature for curing. The specimen were retrieved and the excess liner material from either side was removed using B P knife to have a final specimen with liner size of 3x10x10 between two acrylic blocks of 40x10x10mm (FIG 7).

I. PREPARATION OF UFI GEL PTM LINER SPECIMEN

UFI GEL PTM adhesive was applied to the surface .UFI Gel PTM base and catalyst were dispensed in ratio 1: 1 from the tubes and mixed within 30 seconds to a homogenous and bubble free consistency and it was packed into the space between the acrylic blocks . In total 60 UFI Gel PTM liner specimen were prepared in above manner.

II. PREPARATION OF GC RELINE SOFTTM LINER SPECIMEN

GC RELINETM PRIMER was applied to the surface with a clean dry brush no.7 supplied by the manufacturer .GC RELINETM SOFT liner material was dispensed from the

cartridge into space between the acrylic blocks. In total 60 GC RELINETTM SOFT liner specimen were prepared in the above mentioned manner (FIG 8)

III PREPARATION OF DENTURE CLEANSER SOLUTIONS

Three rectangular containers are taken with 200 ml of water. Fresh solutions of cleanser were prepared adding 1 tablet of Clinsodent[®] in one container and 1 Secure[®] tablet in second container. Water in the third as control. The solutions on all the three containers were changed daily for a period of 180 days. (FIG 9)

DESIGNATION AND DISTRIBUTION OF TENSILE BOND STRENGTH SPECIMEN

Group IA1: 10 samples with Ufi Gel PTM liner were selected and immersed in distilled water for a period of 1 day.

Group IA2: 10 samples with Ufi Gel PTM liner were selected and immersed in distilled water for a period of 180 day.

Group IB1: 10 samples with Ufi Gel PTM liner were selected and immersed in Clinsodent[®] denture cleanser solution for a period of 1 day.

Group IB2: 10 samples with Ufi Gel PTM liner were selected and immersed in Clinsodent[®] denture cleanser solution for a period of 180 day.

Group IC1: 10 samples with Ufi Gel PTM liner were selected and immersed in Secure[®] denture cleanser solution for a period of 1 day.

Group IC2: 10 samples with Ufi Gel PTM liner were selected and immersed in Secure[®] denture cleanser solution for a period of 180 day.

Group IIA1: 10 samples with GC RELINETTM SOFT liner were selected and Immersed in distilled water for a period of 1 day.

Group IIA2: 10 samples with GC RELINETTM SOFT liner were selected and Immersed in distilled water for a period of 180 day.

Group IIB1: 10 samples with GC RELINETTM SOFT liner were selected and Immersed in Clinsodent[®] denture cleanser solution for a period of 1 day.

Group IIB2: 10 samples with GC RELINETTM SOFT liner were selected and Immersed in Clinsodent[®] denture cleanser solution for a period of 180 day.

Group IIC1: 10 samples with GC RELINETTM SOFT liner were selected and Immersed in Secure[®] denture cleanser solution for a period of 1 day.

Group IIC2: 10 samples with GC RELINETTM SOFT liner were selected and Immersed in Secure[®] denture cleanser solution for a period of 180 day

a) EVALUATION OF TENSILE BOND STRENGTH

Universal Testing machine (Instron model no: 3365) is used for testing tensile bond strength. The samples were gripped vertically and firmly between upper and lower cross head jaws of the machine. The tensile force was applied gradually at a cross speed of 2 mm / minute until complete debonding of liner occurred and values are

noted. All the samples in each group are tested similarly. (FIG 10)

Tensile bond strength was calculated in Mega Pascal (MPa) by following formula

$$\text{Tensile bond strength} = \frac{\text{Maximum load (N)}}{\text{Cross Sectional Area (mm}^2\text{)}}$$

The difference in the bond strength of each resilient liner material were determined for the 2 test periods and were evaluated statistically using student t test, one way ANOVA and post HOC test.

FOR HARDNESS TESTING

120 cylindrical specimen of both the liner (60 specimen of Ufi gel P and 60 specimen GC reline soft) were prepared with dimension of 20mm diameter and 12mm height in a standardized mould to evaluate the effect of denture cleanser on the hardness. Hardness testing was done in Shore A durometer.

PREPARATION OF HARDNESS SPECIMEN

A) PREPARATION OF STANDARDIZED BRASS MOULD

Total of 120 cylindrical specimen of soft liner (60 samples of Ufi Gel PTM & 60 samples of GC RELINE SOFTTM) were made of dimension 20mm in diameter and 12mm in height (according to ASTM:D 2240-64T) with the custom made standardized brass mould

B) PREPARATION OF SOT LINER SPECIMEN

Total of 120 cylindrical specimens (20mm x 12mm) were prepared with this brass mould. Middle part of the mould was placed on the base of the brass flask. Soft liner were manipulated according to manufacturer's instruction and packed into the mould space. Then the mould was covered with top portion of flask and tightened the screw. Flask was left 10 minutes at room temperature for complete curing. Once the material was set. Specimens (20mm x 12mm) were removed from the mould and excess was trimmed using BP blade. (FIG 11)

PREPARATION OF UFI GEL PTM & GC RELINE SOFT LINER SPECIMEN

Ufi Gel PTM & GC RELINE SOFT liner material were manipulated according to manufacturer's instruction and packed into the standardized brass mould. Care should taken to avoid the air bubbles and in above manner total of 60 cylindrical UFI GEL P & 60 GC RELINE SOFT liner specimen of dimension (20 x 12mm) were prepared.

DESIGNATION AND DISTRIBUTION OF HARDNESS SPECIMEN (FIG12)

Group IA1 : 10 samples with Ufi Gel PTM liner were selected and immersed in distilled water for a period of 1 day.

Group IA2: 10 samples with Ufi Gel PTM liner were selected and immersed in distilled water for a period of 180 day.

Group IB1: 10 samples with Ufi Gel PTM liner were selected and immersed in Clinsodent[®] denture cleanser solution for a period of 1 day.

Group IB2: 10 samples with Ufi Gel PTM liner were selected and immersed in Clinsodent® denture cleanser solution for a period of 180 day.

Group IC1: 10 samples with Ufi Gel PTM liner were selected and immersed in Secure[®] denture cleanser solution for a period of 1 day.

Group IC2: 10 samples with Ufi Gel PTM liner were selected and immersed in Secure[®] denture cleanser solution for a period of 180 day.

Group IIA1: 10 samples with GC RELINETM SOFT liner were selected and immersed in distilled water for a period of 1 day.

Group IIA2: 10 samples with GC RELINETM SOFT liner were selected and immersed in distilled water for a period of 180 day.

Group IIB1: 10 samples with GC RELINETM SOFT liner were selected and immersed in Clinsodent® denture cleanser solution for a period of 1 day.

Group IIB2: 10 samples with GC RELINETM SOFT liner were selected and immersed in Clinsodent® denture cleanser solution for a period of 180 days.

Group IIC1: 10 samples with GC RELINETM SOFT liner were selected and immersed in Secure® denture cleanser solution for a period of 1 day.

Group IIC2: 10 samples with GC RELINETM SOFT liner were selected and immersed in Secure® denture cleanser solution for a period of 180 day.

b) EVALUATION OF HARDNESS

Specimens were prepared for hardness test using the above mentioned method. Hardness of all the specimens (n=10) in each group were measured using Shore A Durometer which was calibrated according to ASTM D2240, and recorded in shore units. The instrument was held in a vertical position and pressure applied until the foot of the instrument touched the specimen surface. Five readings were taken on each specimen and averaged. All the readings were taken 5 second after firm contact was achieved. These values were statistically analyzed using paired student t test, one way Anova and Post Hoc test. (FIG 13)

LEGENDS:



FIGURE 1 Ufi Gel PTM



FIGURE 2 : GC Reline™ soft liner



FIGURE 3 : Clinsodent® & Secure Denture cleanser tablet



FIGURE 4: Standardized 3 piece brass mould for tensile strength specimen



FIGURE 5 : Standardized 3 piece brass mould for hardness specimen



FIGURE 6 : After curing brass mould with heat cure blocks were opened.



FIGURE 7 : Liner material packed into space between the acrylic blocks

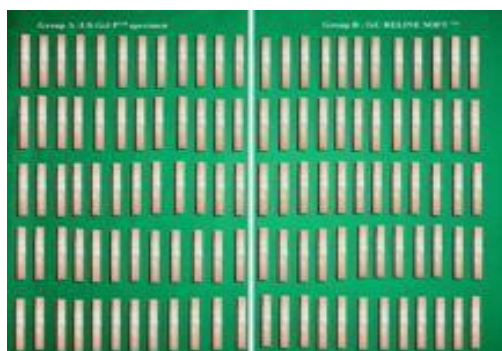


FIGURE 8 : Ufi Gel P & GC RELINE SOFT liner ready for testing tensile bond strength.



FIGURE 9 : Three storage medium.(water ,clinsodent,secure)



FIGURE 10 : Samples assembled on instron Universal testing machine



FIGURE 11: Liner material injected into mould space

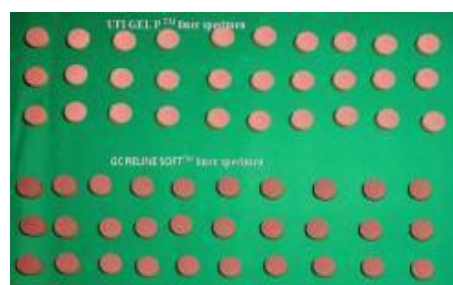


FIGURE 12 : Representation of Ufi GEL P & GC RELINE SOFT liner hardness specimen



FIGURE 13 : Testing of GC RELINE SOFT hardens specimen

TABLE 1: Tensile bond strength values of UFI GEL P TM (GROUP I) after immersion in Water, Clinsodent®, Secure® for a period of 1 day and 180 days

SL. NO.	WATER		CLINSODENT		SECURE	
	IA ¹ 1 DAY (MPa)	IA ² 180 Days (MPa)	IB ¹ 1 DAY (MPa)	IB ² 180 Days (MPa)	IC ¹ 1 DAY (MPa)	IC ² 180 Days (MPa)
1	0.965	0.927	0.951	0.959	0.915	0.655
2	0.962	0.930	0.953	0.951	0.958	0.658
3	0.959	0.917	0.938	0.995	0.959	0.614
4	0.958	0.927	0.937	0.985	0.917	0.652
5	0.980	0.959	0.980	0.991	0.990	0.695
6	0.922	0.959	0.922	0.980	0.952	0.658
7	0.951	0.959	0.980	0.980	0.980	0.655
8	0.959	0.959	0.952	0.959	0.952	0.655
9	0.959	0.958	0.980	0.951	0.980	0.652
10	0.955	0.955	0.951	0.951	0.951	0.655
Mean	.95963	.95913	.95983	.95959	.95983	.65563

TABLE 2: Tensile bond strength value of GC RELINE SOFTTM (GROUP II) after immersion in Water, Clinsodent®, Secure® for a period of 1 day and 180 days

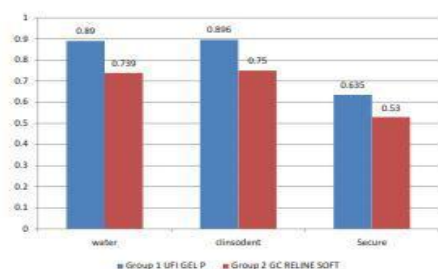
SL. NO.	WATER		CLINSODENT		SECURE	
	IA ¹ 1 DAY (MPa)	IA ² 180 Days (MPa)	IB ¹ 1 DAY (MPa)	IB ² 180 Days (MPa)	IC ¹ 1 DAY (MPa)	IC ² 180 Days (MPa)
1	0.73	0.83	0.74	0.72	0.75	0.54
2	0.72	0.70	0.75	0.74	0.74	0.52
3	0.71	0.70	0.72	0.71	0.71	0.55
4	0.72	0.71	0.73	0.72	0.72	0.51
5	0.76	0.77	0.76	0.75	0.76	0.55
6	0.75	0.78	0.78	0.79	0.78	0.48
7	0.74	0.72	0.79	0.78	0.79	0.56
8	0.73	0.72	0.71	0.71	0.73	0.54
9	0.72	0.72	0.72	0.71	0.72	0.53
10	0.73	0.74	0.75	0.74	0.73	0.52
Mean	.73110	.73990	.74590	.73770	.74330	.53000

TABLE 3: Hardness value of UFI GELP TM (GROUP I) after immersion in water, clinsodent®, secure® for a period of 1 day and 180 days.

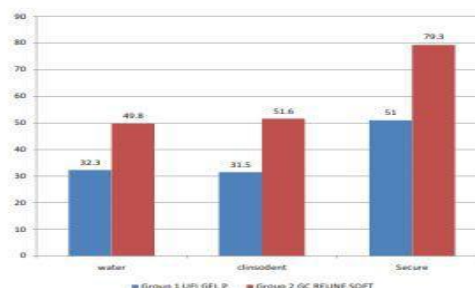
SL. NO.	WATER		CLINSODENT		SECURE	
	IA ¹ 1 Day Shore A	IA ² 180 Days Shore A	IB ¹ 1 Day Shore A	IB ² 180 Days Shore A	IC ¹ 1 Day Shore A	IC ² 180 Days Shore A
1	30.00	30.00	30.00	34.00	30.00	50.00
2	32.00	31.00	32.00	33.00	34.00	48.00
3	31.00	32.00	34.00	34.00	36.00	51.00
4	33.00	34.00	33.00	35.00	32.00	52.00
5	34.00	34.00	32.00	30.00	35.00	50.00
6	30.00	31.00	30.00	30.00	33.00	53.00
7	33.00	31.00	32.00	31.00	31.00	51.00
8	32.00	34.00	30.00	32.00	32.00	52.00
9	31.00	33.00	31.00	30.00	33.00	49.00
10	33.00	32.00	30.00	31.00	34.00	54.00
Mean	31.0000	32.2000	31.4000	31.5000	33.0000	51.0000

TABLE 4: Hardness of value GC RELINE SOFTTM after immersion in water, clinsodent®, secure® for a period of 1 day and 180 days.

SL. NO.	WATER		CLINSODENT		SECURE	
	IA ¹ 1 Day Shore A	IA ² 180 Days Shore A	IB ¹ 1 Day Shore A	IB ² 180 Days Shore A	IC ¹ 1 Day Shore A	IC ² 180 Days Shore A
1	50.00	51.00	51.00	51.00	49.00	80.00
2	49.00	49.00	48.00	47.00	51.00	78.00
3	52.00	51.00	49.00	48.00	52.00	82.00
4	50.00	51.00	50.00	51.00	48.00	83.00
5	51.00	50.00	50.00	52.00	51.00	84.00
6	48.00	51.00	53.00	53.00	50.00	79.00
7	49.00	48.00	52.00	52.00	49.00	78.00
8	51.00	50.00	52.00	51.00	48.00	82.00
9	50.00	49.00	49.00	59.00	53.00	73.00
10	48.00	48.00	50.00	52.00	51.00	74.00
Mean	49.8000	49.8000	50.4000	51.6000	50.2000	79.3000



Graph 1 : Comparison Of Group I And Group II tensile Bond Strength



Graph 2: Comparison of Group I And Group II Hardness

DISCUSSION

Resilient liner are indicated in clinical conditions like patients with bony undercuts, bruxism, congenital or acquired oral defects requiring prosthesis, relief for tori / exostoses, persistent denture sore mouth, radiation therapy, dentures opposing natural dentition and implant supported prosthesis during healing period.

One of the common problems found in the use of denture liners is the adhesion failure between the liner and denture base and most of the liners are not stable in a moist environment of oral cavity. Factors that affect the bond between lining materials and denture bases, includes aging in water, use of a primer with lining material and nature of the material base.^[7] Bond strength and Hardness were the most challenging factors in the use of denture liners,

Tensile bond strength is the maximum stress that the material will withstand before rupture. The tensile bond strength of soft liners were tested in a universal testing machine (**Instron model No: 3365**). Carlos Nelson Elias (2007).^[8] used the same instrument to find the tensile bond strength of soft liners. Therefore the bond strength of silicone resilient liners depends on tensile strength of the materials and adhesive used.^[2]

The bond strength values were found to be reduced for UFI GELP and GC RELINE SOFT liner materials stored in water (control), Clinsodent and Secure subgroups over a period of 180 days. In control group shows a slight reduction in bond strength. Clinsodent group also shows a slight reduction in tensile bond strength but in secure group shows significant reduction in tensile bond strength. This difference between immersion groups may be due to the different chemical

composition of two denture cleansers. These results are in accordance with the Khan Z et al who suggested that water storage reduced resilient liner bond strength. This decrease in bond strength may result from the swelling and stress formation at the bond interface or from a change in the viscoelastic properties of the liner, rendering the material stiffer and able to transmit external loads to the bond site. The results agreed with Polyzois(1992),^[9] who reported that water storage reduced the bond strength of resilient line but contradict the findings of Emmer et al(1995),^[10] Dootz et al,(1993).^[11], Craig and Gibbons,(1961).^[12] who reported that tensile strength of resilient lining materials increased after storage in water. However, a direct comparison of these studies cannot be made because of their variation of mechanical tests and research protocols used. Nikawa et al^[13] and Jin et al (2003).^[14] affirmed that not only the active component, but also other components of the cleansing chemical agent as well as the pH can cause damage to the material. According to Jagger and Harrison (1995).^[15] the effervescent hygiene agents have a chemical and a mechanical cleaning action, resulting in the production of bubbles created by oxygen release during the reaction, which could effect the bond strength.

The variation in tensile bond strength between clinsodent and secure group may be due to the higher ionic concentration of sodium and potassium present in secure denture cleanser solution. Secure denture cleanser tablet which contain potassium mono persulphate which was a strong oxidizing agent. These results are in accordance with the Kazanji and Watkinson (1988).^[16] suggested that materials can absorb water or lose soluble components, depending on their composition and the solution in which they are immersed. It is likely that the higher ionic concentration potassium and sodium of denture cleanser compared to water.^{[17] [18]} led to a higher release of soluble components. The difference in bond strength of (group I) Ufi gel P and (group II) GC reline Soft may be due to the difference in chemical constituents of the two materials used in the study. The filler content may be the reason for the difference in tensile bond strength of the two materials.^[19] This result is in accordance with Y. ABE et al (2009).^[20] in a study done on viscoelastic properties of poly vinyl siloxane denture lining materials reported that the viscoelastic properties of the tested materials appear to be influenced by different compositional parameters such as filler fraction and it was noted that viscoelastic properties can marginally affect the bond strength. action, resulting in the production of bubbles created by oxygen release during the reaction, which could effect the bond strength.

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with the Kazanji and Watkinson (1988).^[21] suggested that materials can absorb water or lose soluble components, depending on their composition and the solution in which they are immersed. It is likely that the higher ionic concentration potassium and sodium of denture cleanser compared to water^[22] led to a higher release of soluble components.

The difference in bond strength of (group I) Ufi gel P and (group II) GC reline Soft may be due to the difference in chemical constituents of the two materials used in the study. The filler content may be the reason for the difference in tensile bond strength of the two materials.^[23] This result is in accordance with Y. ABE et al (2009).^[24] in a study done on viscoelastic properties of poly vinyl siloxane denture lining materials reported that the viscoelastic properties of the tested materials appear to be influenced by different compositional parameters such as filler fraction and it was noted that viscoelastic properties can marginally affect the bond strength.

F. McCabe et al in a study done on the GC reline soft, GC reline Extra soft and GC reline ultra soft on the adhesive bond strength and compliance, had reported that the filler content of GC reline soft, GC reline Extrasoft and GC reline Ultrasoft were 37%,30%,18%.respectively, which is higher than Ufi gel P. (23) Student t test is used to compare between group I (Ufi gel P) and group II (GC reline soft) hardness specimen, Ufi gel P specimen showed lower shore A hardness value (32.3, 31.5,51.6 shore A) compared to GC reline soft (49.8,51.6,79.3 shore A) in each storage medium (Water, Clinsodent, Secure) respectively over a period of 180days. Group II (GC reline soft) shows significant increase in hardness value compared to group I (Ufi gel P).Shore A hardness values of all the resilient liners were higher over a period of 180 day immersion of immersion. The results of the current study are in agreement with C a n a y S e t a l (1 9 9 9) (24) a n d W a g n e r W C e t a l (1 9 9 9).^[25] who reported that water storage increased resilient liner hardness In acrylic resin based products and silicone based products.. Results of this study supported by Mese and Guzel (26)who evaluated the effect of storage duration on the hardness and tensile bond strength of 2 acrylic based and 2 silicone based resilient liners. They concluded that after 6 months hardness value of all resilient liners evaluated were higher with increased duration of immersion.

At 180 days. Group I and group II specimens in secure solution shows a significant increase in the shore A hardness compared to first day. Secure denture cleanser solution contain potassium mono persulphate and sodium bicarbonate in addition to sodium peroxide which contribute to the higher ionic concentration in solution which may alter the surface properties of silicone liner. This result in accordance with the study of Kazanji et al.(1988)^[21] stated that soft lining material can absorb water or lose soluble components based on their structure and the chemical solution in which they are soaked. The

authors believe that the higher ionic concentration of denture cleanser such as Potassium and Sodium resulted in a higher release of soluble constituents when these cleansers are compared with water Pavan et al 2007.^[27] These authors observed an increase in the hardness of resilient materials immersed in cleaning products. Botega et al.^[28], on the other hand, demonstrated a decrease in the hardness of the tested silicon based liners after the treatment with different denture hygiene solutions. While in control and clinsodent subgroup there is a mild increase in the hardness.

GC reline soft shows a significant increase in hardness because of high concentration of filler content (37%). The mechanical properties of silicone materials without fillers are generally insufficient for most applications. Increases in hardness and strength by the formation of bonds between the filler and the silicone polymer (29) Water absorbed into the liner and act as a “filler” by stressing the surrounding polymer matrix and, as a result, stiffening of the material occurs (30) with the largest changes in the viscoelastic properties of silicones after 60 days of wet storage.^[24]

All the specimen tested in the study showed an increase in surface hardness with the time and decrease in tensile bond strength. However, significant difference in bond strength and hardness was observed in secure denture cleanser. Comparatively clinsodent proved to be a better cleansing solution as the specimens stored in this did not have significant changes in the mechanical properties. Overall results indicated that Ufi gel P silicone liner performed significantly better than GC reline soft resilient liners with minimal changes in mechanical properties when stored in cleansing solution. The present study was an *in vitro* study. The soft denture liners are meant to function with denture in the oral cavity. The nutrient rich environment of the oral cavity does not fully match the *in vitro* nature of the present study. Therefore, the behavior of denture lining materials in this study may only partially predict the clinical performance. Despite increasing usage of soft resilient liners in prosthetic dentistry and the importance of cleaning to prevent microbial colonization, factors such as absorption and solubility, roughness, bond strength, color stability and viscoelastic properties need to be further investigated to define the best cleansing procedure for these materials.

The following conclusions were drawn from the present study.

1. Ufi gel PTM was proved to be a better material than GC reline soft TM liner with less significant variations in tensile bond strength and hardness when stored in cleansers for 180 days
2. Soft liners stored in cleansing solutions and water did not show much significant variation in mechanical property. Hence it is advisable to use cleansers for better antimicrobial property.

3. Soft liners stored in Clinsodent® showed minimal variation in mechanical property compared to secure.
4. Secure® denture cleanser solution significantly effected the tensile bond strength and hardness properties of Ufi gel PTM and GC reline soft TM liner material.
5. Ufi gel PTM liner material showed significantly less variation in tensile bond strength and hardness for a period 180 days.
6. GC reline soft TM showed a significant variation in tensile bond strength and hardness over a period of 180 days.

SUMMARY

This study was conducted to evaluate and compare the effect of denture cleansers on tensile bond strength and hardness of two silicone based resilient liners on short and long term storage. Two commercially available Ufi gel TM P and GC reline soft TM auto polymerizing silicone liners and two alkaline peroxide type Clinsodent® and Secure® denture cleansers and Water (control) were selected as storage medium for first day and 180 days.

Tensile bond strength and hardness data were analyzed using One way (ANOVA), student t test and post HOC test for multi comparison. Result showed that when comparing Ufi gel P and GC reline soft specimens in Secure denture cleanser stored for 180 days showed a significant decrease in tensile bond strength and increase in hardness. In water and Clinsodent storage showed a less significant variation in tensile bond strength and hardness of both silicone liners. GC reline soft is a harder material compared to Ufi Gel P. Ufi gel P showed initial high bond strength and softness which retained over a period of 180 day in water and Clinsodent denture cleansers. Study showed that variation in composition of denture cleansers and duration which will effect the properties of resilient liner. Conclusion drawn from this study showed that Clinsodent denture cleanser with a main ingredient of alkaline peroxide showed significant less effect on tensile bond strength and hardness properties of silicone liners on long term storage. Rather than using water alone, it is advisable to use alkaline peroxide which have an inherent antimicrobial property for cleansing the denture lined with silicone based resilient liner without effecting the properties.

REFERENCES

1. Kawano F, Kon M, Koran A, Matsumoto N. Shock-absorbing behavior of four processed soft denture liners. J Prosthet Dent 1994; 72: 599-605.
2. Mack PJ. Denture soft linings materials available. Aust Dent J 1989; 34: 517-21.
3. El Hadary A, Drummond J L. Comparative study of water sorption, solubility, and tensile bond strength of two soft lining materials. J Prosthet Dent 2000; 83: 356-61.

4. Kawano F, Dootz ER, Koran A 3rd, Craig RG. Comparison of bond strength of six soft denture liners to denture base resin. *J Prosthet Dent* 1992; 68: 368-71.
5. Nikawa H, Iwanaga H, Hamada T. Effects of denture cleansers on direct soft dentures lining materials. *J Prosthet Dent* 1994; 72: 657-662.
6. Sinobad D, Murphy WM, Hugget R, Brooks S. Bond strength and rupture properties of some soft denture liners. *J Oral Rehabil*, 1992; 19: 151- 60.
7. Carlos Nelson Elias Effect of thermocycling on the tensile and shear bond strengths of three soft liners to a Denture base resin. *J. Appl.Oral Sci.* 2007; 15(1): 18-23.
8. Polyzois. Adhesion properties of resilient lining materials bonded to light cured denture resin *J Prosthet Dent*1992; 68: 854-8.
9. Emmer TJ , Vaidynathan T K. Bond strength of permanent soft denture liners bonded to the denture base. *J Prosthet Dent* 1995; 74: 595-601.
10. Dootz ER, Koran A, Craig RG. Physical property comparison of 11 soft denture lining materials as a function of accelerated aging. *J Prosthet Dent*1993; 69: 114-19.
11. Craig RG, Gibbons P. Properties of resilient denture liners. *J Am Dent Assoc* 1961; 63: 382-90.
12. Nikawa H, Jin C, Makihira S, Egusa H, Hamada T, Kumagai H. Biofilm formation of *Candida albicans* on the surfaces of deteriorated soft denture lining materials caused by denture cleansers in vitro. *J Oral Rehabil.* 2003; 30: 243-50.
13. Jin C, Nikawa H, Makihira S, Hamada T, Furukawa M, Murata H. Changes in surface roughness and color stability of soft denture lining materials caused by denture cleansers. *J Oral Rehabil.* 2003; 30: 125-30.
14. Jagger DC, Harrison A. Denture cleansing the best approach. *Br Dent J.* 1995; 178: 413-7.
15. Kazanji , Watkinson AC. Soft lining materials: their absorption of, and solubility in, artificial saliva. *Br Dent J* 1988; 165: 91-4.
16. Graham BS, Jones DW, Sutow EJ. An in vivo and in vitro study of the loss of plasticizer from soft polymer gel materials. *J Dent Res* 1991; 70: 870-3.
17. Kazanji , Watkinson AC. Soft lining materials: their absorption of, and solubility in, artificial saliva. *Br Dent J* 1988; 165: 91-4.
18. Al Athel MS, Jagger RG. Effect of test method on the bond strength of a silicone resilient denture lining material. *J Prosthet Dent* 1996; 76: 535-40.
19. Y. Abe, T. Taji, K. Hiasa, K. Tsuga & Y. Akagawa. Dynamic viscoelastic properties of vinyl polysiloxane denture soft lining materials. *J Oral Rehabilitation* 2009; 36: 887-893.
20. Kazanji, Watkinson AC. Soft lining materials: their absorption of, and solubility in, artificial saliva. *Br Dent J* 1988; 165: 91-4.
21. Graham BS, Jones DW, Sutow EJ. An in vivo and in vitro study of the loss of plasticizer from soft polymer gel materials. *J Dent Res* 1991; 70: 870-3.
22. Al Athel MS, Jagger RG. Effect of test method on the bond strength of a silicone resilient denture lining material. *J Prosthet Dent* 1996; 76: 535-40.
23. Y. Abe, T. Taji, K. Hiasa, K. Tsuga & Y. Akagawa. Dynamic viscoelastic properties of vinyl polysiloxane denture soft lining materials. *J Oral Rehabilitation* 2009; 36: 887-893.
24. Wagner WC, Kawano F, Dootz ER, Koran A 3rd. Dynamic visco elastic properties of processed soft denture liners. Part II--Effect of aging. *J Prosthet Dent* 1995;74: 299-304.
25. Mese A, Guzel KG. 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* 2008; 99: 153-9.
26. Pavan S, Arioli Filho, Dos Santos, Nogueira AU. Effect of disinfection treatments on the hardness of soft denture liner materials. *J Prosthodont.* 2007; 101- 6.
27. Botega DM, Carmo Filho JL, Mesquita MF, Nóbilo MAA, Henriques GEP. Influence of toothbrushing on surface roughness of soft denture liners: an in vitro study. *Rev Pós Grad.* 2004; 11: 125-9.
28. Santawisuk W. Kanchanasavita W.; Sirisinh C, Harnirattisai C. Mechanical properties of experimental silicone soft lining materials. *Dent. Mater. J.* 2013; 32: 970-975.
29. Saber Sheikh K. The Viscoelastic Properties of Some Dental Soft Lining Materials. Ph.D. Thesis, University of London: London, UK, 1997.