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Original Research Article

Comparison of the Effect of Denture Cleansers on Hardness of Silicone Based Resilient Liner Attached to Heat Cured Denture Base Material

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Abstract: The purpose of this study is to evaluate and compare the hardness of silicone-based resilient liners attached to heat cured denture base material, when treated with different denture cleansing solutions. Sixty cylindrical liner specimens (30 UFi GEL P™ and 30 GC RELINE™ SOFT) were tested for hardness after immersing in various denture cleansers (water, Fittydent, Clinsodent) for a period of 180 days. Shore a Durometer was used for testing hardness. Mann- Whitney test, one way ANOVA tests were used for statistical analysis. Hardness value of water and Fittydent decreased the hardness value of UFi GEL P^{TM} over a period of 180 days, while Clinsodent showed a high significant increase in the hardness value of UFi GEL P$^{TM.}$ When compared further, for 1st day and 180 days of hardness values in sub group, we found significant difference in the value of clinsodent (p=.042). Conclusion: In conclusion, UFi GEL P^{TM} was observed as a better material when comparing with GC RELINE^{TM} SOFT with slight different variations in hardness when stored in denture cleanser over a period of 180 days. In addition, there is no much significant variation of mechanical properties of soft liners when stored in cleansing solutions and water. Hence, it is preferable to use denture cleansers due to its antimicrobial properties.
Keywords: resilient liners, silicone, clinsodent

INTRODUCTION

Complete denture bases are fabricated commonly from rigid denture base materials like acrylic, vinyl and other resin polymers [1]. The fit of the denture base to the alveolar ridge progressively declines as the alveolar ridge resorbs, which affects denture stability, support and retention [2]. Relining is indicated to recapture the fit of the denture base, especially when the denture still retains proper vertical dimension, occlusal relationship and esthetics [3] and thereby eliminate the need for making new dentures [4].

The ideal properties for a soft liner include resilience, tear resistance, viscoelasticity, biocompatibility, lack of odor and taste, adhesive bond strength, low solubility in saliva, low adsorption in saliva, ease of adjustability, dimensional stability, color stability, lack of adverse effect on denture base material, resistance to abrasion, and ease of cleaning [5]. Two types of chair-side denture relining materials widely used in dentistry, includes hard and soft reliners. Hard relining materials are subdivided into several groups such as heat-cured, self-cured and light-cured. Soft or resilient reliners are preferred for sensitive mucosal tissues and are divided into the four groups based on their chemical structures like plasticized acrylic resins (chemical or heat cured), vinyl resins rubbers (polyurethane and polyphospazine type) and silicone rubbers.

Resilient denture lining material is as an elastic or viscoelastic material applied to the fitting surface of a denture. They act as a cushion for the denture bearing mucosa through absorption, dampening, and redistribution of forces transmitted to the stress-bearing areas of edentulous ridges, provide more equal force distribution, reduce localized pressure, and improve denture retention by engaging undercuts [6].There are mainly two types of resilient liners used which include, silicone based and acrylic resins. Silicone based resilient liners include self-cure/room temperature vulcanizing (RTV) silicones and heat temperature vulcanizing (HTV) silicone (short-term or long-term) [7].

Water, hypochlorite solutions, alkaline peroxide solutions, acidic disinfectants solutions and enzymatic solutions are commonly used cleansing agents in clinical practice. Water sorption, bonding agents, processing methods, chemistry of the material and changes in the bond strength in the harsh oral environment are important factors responsible for variation in hardness and tensile strength of silicone based soft denture liners [8].

However, these soft liners exhibit multiple clinical failures characterized by loss of adhesion to denture base surface, poor tear strength and/or bulk deterioration, accumulation of debris and plaque, loss of resilience and fungal or microbial accumulation, bond failure. Many of these problems results from the increased water sorption and solubility when dentures are soaked in saliva during use or kept in water or aqueous disinfecting solution during storage [7].

One of the most serious problems with these materials are bond failure between the resilient denture liner and denture base as the ability of the liner to effectively absorb and uniformly transmit the masticatory stresses is dependent on the integrity of the bond [9]. The purpose of this study is to evaluate and compare the effect of three commonly used denture cleansers on hardness of silicone based resilient liner to heat cure denture base material.

MATERIALS AND METHODS

Hardness testing

Preparation of Hardness Specimen

60 cylindrical specimens of both liner (30 specimen of UFi GEL P™ and 30 specimens of GC RELINE™ SOFT) were processed with dimension of 20 mm diameter and 12 mm height by using a standardized mould to determine the effect of denture cleanser on the hardness (Fig 1). Shore A Durometer was used for testing hardness.

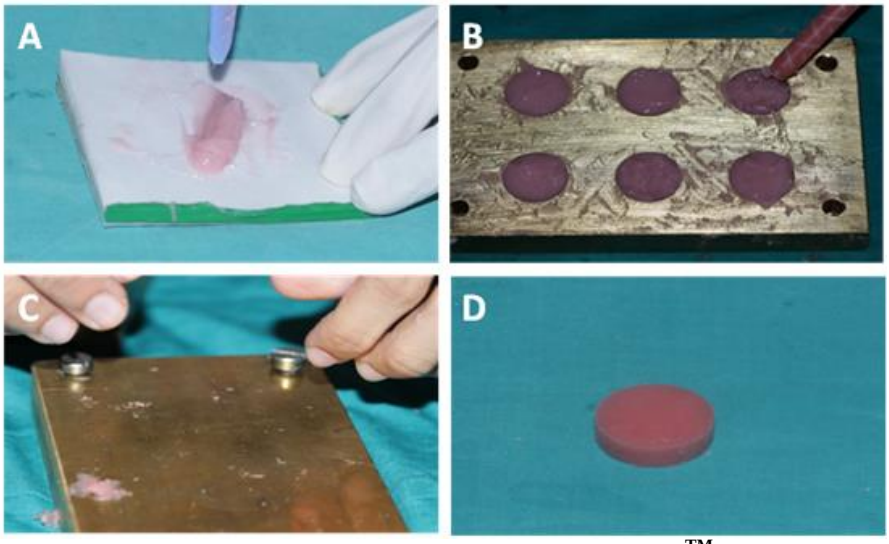

Fig-1: A. Preparation of testing hardness (specimens) A. Mixing of UFi GEL P™ on a mixing pad. B. Preparation of Hardness Specimen. C. Tightening of screws after loading soft liner into brass mould. D. Final specimen for hardness testing

Preparation of Standardized Brass Mould

A custom made standardized brass mould was used to prepare the cylindrical specimen. Total 60 numbers of cylindrical specimens of soft liner (30 samples of UFi GEL P™& 30 samples of GC RELINE SOFT™ soft liner) with dimension 20 mm in diameter and 12 mm in height are made. Flask consists of three parts containing upper, middle and lower part which is rectangular in shape. Middle parts 6 cylindrical mould space of dimension 20 mm×12 mm. The parts are joined by four screws at the corners of mould. It provides fabrication of 6 soft liner specimens at one time.

Preparation of Soft Liner Specimen

Specimens with measurement of 20 mm × 12 mm were processed by using the same mould. 60 numbers of specimens were prepared. Soft liners were prepared by following instructions given on the manufactures pack and then poured into the mould space. Then the top portion of the flask was kept above the middle portion and fitted by screws. For complete curing, the flask was left for 10 minutes at room temperature. The specimens were separated from the mould after 10 minutes. A Bard Parker blade was used for trimming the excess part from the specimen.

Preparation of UFi Gel P™ Liner Specimens

UFi GEL P™ liner is available in the form of two pastes. Mixing was done under manufactures instructions. Then mix was filled into the mould space. Presence of air bubbles should be prevented. 30 numbers of specimens were prepared in the same manner.

Preparation of Gc Reline Soft™ Liner Specimens

An auto-mix gun was used to inject the liner in to the mould space. Air bubbles should be avoided while making the specimen. The flask was left for 10 minutes, for curing. 30 numbers of specimens were prepared.

Distribution and Designation of Hardness Specimen

To determine the role of denture cleanser on hardness on short and long period shortage, entire 60 cylindrical specimens of silicone liner were carried out and separated into 2 major groups based on two brands of liner materials. Each group contains 30 samples of UFi GEL P^{TM} and GC RELINE^{TM} SOFT liner. 30 samples of UFi GEL P^{TM} considered as group I and the GC RELINE™ SOFT liner considered as group II. Group I samples again divided into 3 sets which was then immersed into 2 denture cleanser solutions and water (10 specimens in each group). 5 samples from each group were tested for hardness after 1 day and other 5 samples tested after 180 days of storage. Group II samples also prepared by the same manner for testing hardness.

GROUP I A^{1}: 5 samples of UFi GEL P^{TM} were selected and kept in distilled water for a period of 1 day.
GROUP I A^{2}: 5 samples of UFi GEL P^{TM} selected and immersed in distilled water for 180 days.
GROUP I B^{1}: 5 samples of UFi GEL P^{TM} were immersed in Fittydent® Super cleansing denture cleanser solution for one day.
GROUP I B^{2}:5 samples of UFi GEL P^{TM} were selected and kept in Fittydent® Super cleansing denture cleanser for a period of 180 days.
GROUP I C^{1}: 5 samples of UFi GEL P^{TM} were selected and kept in Clinsodent® Powder denture cleanser for 1 day.
GROUP I C^{2}: 5 samples of UFi GEL P^{TM} were immersed in Clinsodent® Powder denture cleanser for 180 days.
GROUP II A^{1}:5 samples of GC RELINE^{TM} SOFT were kept in distilled water for one day.
GROUP II A^{2}:5 samples of GC RELINE^{TM} SOFT were kept in distilled water for 180 days.
GROUP II B^{1}: 5 samples of GC RELINE^{TM} SOFT were kept in Fittydent®Super cleansing denture cleanser solution for one day.
GROUP II B^{2}: 5 samples of GC RELINE^{TM} SOFT were kept in Fittydent® Super cleansing denture cleanser solution for 180 days.
GROUP II C^{1}: 5 samples of GC RELINE^{TM} SOFT were kept in Clinsodent® Powder denture cleanser solution for a period of one day.
GROUP II C^{1}: 5 samples of GC RELINE^{TM} SOFT were kept in Clinsodent® Powder denture cleanser solution for 180 days.

Evaluation of Hardness

Hardness of each specimen (n=5) measured by Shore A Durometer and recorded in Shore units. The instrument has a blunt indenter 1/32 inches diameter which tapers into a 1/16 inch cylindrical. The level arrangements marked in a scale which was attached to the indenter. The readings starts from 0 to 100 Shore A hardness units.

The instrument kept in a vertical position and pressure was applied. Reading taken when the foot of the instrument touches the specimen surface. Readings were marked by 5 seconds after there was a firm contact found. The values are determined statistically using paired student t test, one way Anova and Post Hoc test.

Statistical Analysis

Statistical analysis was performed using SPSS, Version 22.0. (IBM Corp). Results for categorical data are summarized using frequencies and percentages. Continuous variables are reported as means ± standard deviation. All readings were taken for 2 test periods and values were statistically assessed using Mann- Whitney test, one way ANOVA test and Post Hoc test. The value of $p< 0.05$ was considered statistically significant.

RESULTS

Hardness value of UFi GEL P^{TM} (Group 1) immersed in water, fittydent™ and clinsodent™ for a period of one day and after six months (180 days). The results shows that, hardness value of water and Fittydent decreased the hardness value of UFi GEL P^{TM} over a period of 180 days, while Clinsodent showed a high significant increase in the hardness value of UFi GEL P^{TM} (Table 1).

Table 1: Hardness value of UFi GEL P^{TM} (GROUP I) after immersion in water, fittydent™ and clinsodent™ for a period of one day and 180 days

	WATER		**FITTYDENT**		**CLINSODENT**	
SL NO	I A^{1} 1 Day Shore A	I A^{2} 180 Days Shore A	I B^{1} 1 Day Shore A	I B^{2} 180 Days Shore A	I C^{1} 1 Day Shore A	I C^{2} 180 Days Shore A
1	32.00	31.00	30.00	29.00	30.00	64.00
2	33.00	31.00	30.00	29.00	30.00	66.00
3	32.00	31.00	30.00	29.00	30.00	67.00
4	32.00	34.00	30.00	29.00	31.00	66.00
5	31.00	31.00	31.00	27.00	30.00	65.00
Mean	**32.00**	**31.60**	**30.20**	**28.60**	**30.20**	**65.60**

Hardness value of GC RELINE™ SOFT (Group 2) immersed in water, fittydent™ and clinsodent™ for a period of one day and after six months (180 days). The results shows that, hardness value of water and Fittydent decreased the hardness value of GC RELINE™ SOFT over a period of 180 days, while Clinsodent showed a high significant increase in the hardness value of UFi GEL P™ (Table 2).

Table 2: Hardness value of GC RELINE™ SOFT (GROUP II) after immersion in water, Fittydent ™, and Clinsodent™ for a period of one day and 180 days.

	WATER		FITTYDENT		CLINSODENT	
SL NO	**II A¹ 1 Day Shore A**	**II A² 180 Days Shore A**	**II B¹ 1 Day Shore A**	**II B² 180 Days Shore A**	**II C¹ 1 Day Shore A**	**II C² 180 Days Shore A**
1	57.00	57.00	55.00	54.00	55.00	74.00
2	56.00	55.00	53.00	57.00	53.00	74.00
3	57.00	57.00	54.00	55.00	55.00	76.00
4	56.00	55.00	55.00	57.00	55.00	74.00
5	57.00	55.00	53.00	53.00	53.00	75.00
Mean	**56.60**	**55.40**	**55.20**	**54.80**	**55.00**	**74.60**

When compared further, for 1st day and 180 days of hardness values in sub group, we found significant difference in the value of clinsodent (p=.042). However, no significant differences in hardness value were found in water and Fittydent (Table 3).

Table 3: Descriptive Statistics For Hardness Of Group I (Ufi Gel P™) And Comparing First Day And 180 Day Values Of Sub Group I A, I B, I C

Sub groups	N	Mean	Std. Deviation	Median	Mean difference	S.D of difference	Wilcoxon signed rank test Z value	P value
1st day	5	32.00	.71	32.000				
Water	5	31.60	1.34	31.000	.400	1.51600	.590	.587
180 days								
1st day	5	30.20	.447	30.000				
Fittydent	5	28.60	.894	29.000	1.600	1.342	.491	.680
180 days								
1st day	5	30.00	.447	30.000				
Clinsodent	5	65.60	1.140	66.000	-35.400	1.140	2.03	.042
180 days								

DISCUSSION

One of the most clinical challenging issues in Prosthodontics is hardening and debonding of soft liners from the denture base with time. Resilient liners are more preferred to patients with bony undercuts, relief for bruxism, persistent denture sore mouth, radiation therapy, dentures opposing natural dentition, and over implant supported prosthesis especially during healing period [10, 11].

The two commonly used auto polymerizing addition silicone based lining materials were taken for this study, UFi GEL P™ liner and GC RELINE™ SOFT. The Ufi Gel P™ is a permanent soft. Addition silicone relining material available in tubes as a two paste system containing base and catalyst. It also provides an adhesive which has silane and 2-butanone. It is indicated in treatment for pressure spot, cushioning of sharp alveolar process, re-adaptation of dentures and permanent soft relining material for full or partial dentures. GC Reline™ Soft is a permanent, soft, resilient, chair-side vinyl polysiloxane denture reline material. It is dispensed in catridge form and it provides an adhesive called GC RELINE™ PRIMER for better bonding between the soft liners and dentures. The bonding between silicone based soft lining materials and acrylics resin assisted by the use of silicone polymer softens the denture base surface when in contact with a volatile solvent or alkylsilane bonding agents. Evaporation of the solvent, the molecules of silicone penetrates into polymethyl methacrylate matrix, which forms a mechanical union on curing stage surface of the liners. After mixing both components, hydroxylation reaction takes place and by adding Si-H from the hydride functional siloxanes which produce bonds across the unsaturated bonds results formation of vinyl functional siloxanes [12]. The most effective cleansing method for dentures is chemical method. Therefore two commonly available denture cleansers of

alkaline peroxide were selected for this study. They includes, Fittydent® and Clinsodent®.

A total number of 60 specimens were prepared for hardness as 60 UFi GEL P™ and 60 GC RELINE™ SOFT. A cylindrical shaped specimen of 30 UFi GEL P ™ and 30 GC RELINE ™ SOFT prepared by using standardized brass mould according to ISO specification NO: 10139. In Water (Subgroup IA) 180 day specimen shows a mean hardness value of 31.60 Shore A comparatively lower than first day mean hardness value of 32.00 Shore A which is found as not significant. In Fittydent (Subgroup IB) 180 day specimen showed a mean hardness value of 28.60 Shore A which is slightly lower than first day mean hardness value of 30.20 Shore A which is found as not significant. In Clinsodent (Subgroup IC) 180 day specimen showed mean hardness value of 65.60 Shore A comparatively higher than first day mean hardness of 30.20 Shore A which found as highly significant ($P< 0.001$). GC RELINE™ SOFT showed higher Shore A hardness value (55.40, 54.80 and 74.60) compared to UFi GEL P™ (31.60, 28.60, and 65.60) in each storage medium over a period of 180 days. It revealed that GC RELINE™ SOFT (Group II) shows an increase in hardness value compared to UFi GEL P™. In the present study Clinsodent® showed a significant increases in hardness and decrease in tensile strength. This was in accordance with previous studies.

Shore A hardness values of all the resilient liners were higher or similar over a period of 180 days of immersion. Study of Canay *et al* [13] and Wagner *et al* [14] explains the result of current study. They found that the water storage increased resilient liner hardness in acrylic-resin based products and silicone-resin based products.

In the present study UFi GEL P™ obtained lesser hardness (28.60 Shore A) reading in Clinsodent® Powder (65.60) followed by Fittydent® Super Cleansing Tablets (28.60) and in water (31.60) compared to GC RELINE™ SOFT liners. Botega *et al* [15] analyzed that a mild increase in hardness of silicone specimen which immersed in Clinsodent subgroup. According to ISO specifications, hardness value of Shore A durometer should be $\leq$ 55is soft and $\leq$ 35 is extra-soft. UFi GEL PTM material contains less Filler (30%). But in case of GC RELINE™ SOFT, it shows a significant increase in hardness and due to its high concentration of the filler content (37%).

CONCLUSION

The study evaluated the effect of denture cleansers on hardness of two silicone based resilient liners (UFi GEL P™ and GC RELINE™ SOFT). It was observed that UFi GEL P™ is better material than GC RELINE™ SOFT with slight different variations in hardness when stored in denture cleanser over a period of 180 days. In addition, there is no much significant variation of mechanical properties of soft liners when stored in cleansing solutions and water. Hence, it is preferable to use denture cleansers due to its antimicrobial properties.

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