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Estimation of the peel bond strength of the silicone soft liner following denture base treatment: An *in vitro* study

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Abstract
Excessive resorption of the residual ridges may cause impairment of stability of the denture bases, which is accompanied by soreness, pain and discomfort to the patient masticatory system. Soft denture liners are an important adjunct in the treatment of removable partial and complete denture patients particularly those who are medically compromised.

Keywords: Peel bond strength, silicone soft liner, acrylic soft liner, heat cure resin

Introduction
The study was conducted to evaluate the peel bond strength of some of the commercially available soft liners with denture base resin and the effect of surface pre-treatment of denture base resin. The silicone soft liner bonded to the treated surface of the denture base resin with methyl for 180 seconds exhibited higher bonding ability. Soft denture liners are an important adjunct in the treatment of removable partial and complete denture patients particularly those who are medically compromised. The present study was conducted to evaluate the peel and tensile bond strength of some of the commercially available soft liners with denture base resin and the effect of surface pretreatment of denture base resin with methyl metha acrylate.

Aim of the study
To study the peel bond strength of the auto polymerized acrylic and silicone based soft liners bonded to the heat cure denture base

Methods
Peel bond strength tests were carried out with a universal testing machine named Lloyed instrument

Materials Used

Table 1: Description of materials used for determining peel bond strength

Sl. No	Materials Commercial Name	Type of polymerization	Form of the materials	Manufacturers Name
1	G.C Reline TM Soft (Fig. I)	Auto polymerized silicone soft liner	Supplied as cartridge (base & catalyst)	G.C corporation Tokyo. Japan
2	COE – Softtm Resilient Denture Liner (Fig. IA)	Auto polymerized acrylic soft liner	Powder & Liquid	G.C America inc. Made in U.S. A
3	Acrylan–H	Heat cure	Powder & Liquid	Asian acrylates
4	Acrylan–H	Heat cure	Liquid (For pretreatment procedure)	Asian acrylates

Preparation of the test samples
Details of the metal dies
Two rectangular steel dies for a size of 40 x 10 x 10mm and one steel die for a size of 10 x 10 10 x 3mm were prepared and all these surfaces were smooth and flat with sharp edges. Theses steel dies are used to fabricate the acrylic blocks and soft liners blocks respectively.

Preparation of heat cured acrylic blocks
Mold space was created from one steel die size of 40 x 10 x 10mm by using addition silicon putty material. Wax blocks were prepared by pouring the molten wax into the mold space. A total number of 40 wax patterns were prepared

Preparation of mold space for liner placement
The two rectangular shaped steel dies 40 x 10 x 10mm and one steel die 10 x 10 x 3mm were flasked with type II gypsum. The size 10 x 10 x 3mm steel die placed in-between the two steel dies of 40 x 10 x 10mm. After the flasking procedure the dies were removed to create a mold space. The 40 x 10 x 10mm mold space was used for placement of acrylic blocks which are already fabricated and 10 x 10 x 3mm mold space was used for soft liner placement.

Peel bond strength
A total of 40 acrylic plates of dimensions 75 x 25 x 3mm were prepared in heat cured denture base resin. The polymethylmetha acrylate plates were ground with 320-grit silicone carbide paper to remove surface irregularities and excess material. These Forty plates were then divided into four groups.
Group E, Group F, Group G, Group H
Each group contains ten samples and each sample consists of one acrylic plate bonded with soft liner.

- Group E and G samples surfaces were not pretreated with methyl metha acrylate.
- Group F and H samples surfaces were pretreated with methyl metha acrylate for 180 seconds.
- Auto polymerized silicone soft liner were bonded to group E and F
- Auto polymerized acrylic soft liner were bonded to group G and H

Fig 1 A: Mold space for samples

Fig 1 B: Acrylic plate with soft liner

Preparation of the test samples
Two rectangular steel dies were prepared and it has two parts.
LID, BASE

Lid: The dimension of the lid is 85mm length X 35mmwidth X 4mm thickness. The surfaces of the lid were smooth, flat and the corners were rounded.

Base: Base metal die has two sides.

1. One side of the steel die, mold space was prepared for the dimension of 75mm length x 5mm depth x 25mm width. The surfaces of the steel die mold space were smooth, flat and with sharp edges. This mold space was used for soft liner attachment to the polymethyl methacrylate plate.
2. Other side of the steel diehas a rectangular shape elevation of 75mm length x 25mm width X 3mm height. This elevated side of the die was used for the preparation of acrylic plate.

Preparation of acrylic plates
A modeling wax sheet was used to box the elevated side of the steel die. Die stone was mixed and poured to create a mold space. A total number of twenty-die stone mold space were prepared. Molten wax was poured into the mold space and processing was done by conventional technique. The total surface area of the acrylic plate, the space having the dimensions of 50mm length X 25mm width was covered by polyethylene sheet and remaining portion of acrylic plate having the dimensions of 25mm length X 25widthmm was left uncovered to facilitate the bonding of soft liner over this surface.

Preparation of group e samples
The part of the acrylic plates to be bonded with soft liner were coated with primer R and dried with clean air then it was placed in the mold space of steel die. The acrylic plate occupies the mold space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized silicone soft liner which is packed over the acrylic plates and the soft liner was covered by polyethylene sheet over that lid was placed and it was compressed for 10 minutes under the bench press, the excess materials were removed by scalpel blade. In the prepared sample out of total dimension of 75mm length X 25mm width X 2mm thickness only 25mm length X 25mm width of the liner was bonded to the acrylic plate. The remaining part of the soft liner was not bonded to facilitate the attachment with testing machine.

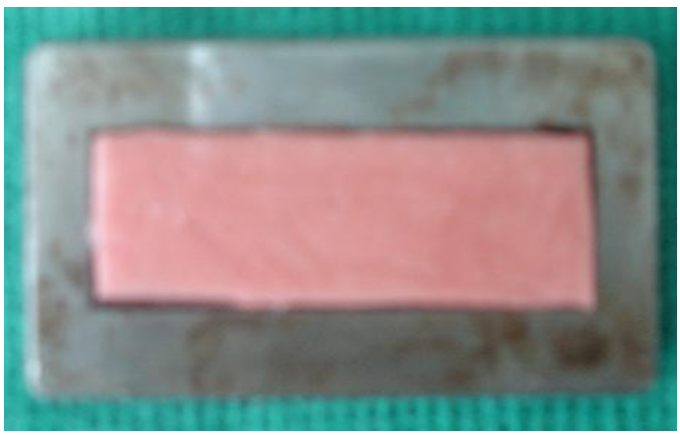

Fig 2: Samples preparations with steel die

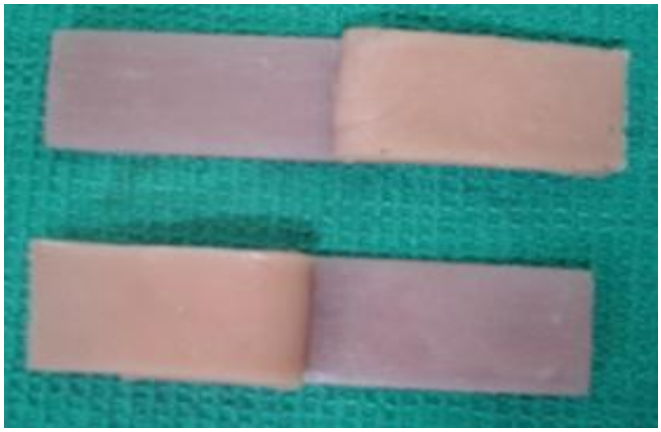

Fig 3: Description of bonded soft liner with pre treated acrylic plate with methyl metha acrylate for 180 seconds

Preparation of group f samples

The surface of the acrylic plates to be bonded with soft liner were pretreated with methyl metha acrylate for 180 seconds. The primer R was coated gently over the treated surfaces with a brush and thenpolymethylmetha acrylate plate was placed in the mold space of steel die. The acrylic plates occupies the space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized silicone soft liner, which is packed and it was compressed for 10 minutes under the bench press,

Preparation of group g samples

The acrylic plate was placed in the mould space of steel die and it occupied the space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized acrylic soft liner which is packed and it was compressed for 10 minutes under the bench press.

Preparation of group h samples

The surface of the acrylic plates to be bonded with soft liner were pretreated with methyl metha acrylate for 180 seconds, and then the specimens were left to dry for 2minutes and it was placed in the mold space of steel die. It occupied the space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized acrylic soft liner which is packed.

Testing the samples

Peel bond strength tests were carried out with a universal testing machine named Lloyed instrument. The universal testing machine was connected to an IBM computer. In peel test, the stress is limited to a line at the edge of the joint as the fibers of the soft liners are stretched and pulled away whereas in the tensile test the whole cross sectional area of the bonded surface is under stress.

The specimen was placed in Lloyed universal testing machine at 180-degree angle with the polymethylmetha acrylate plate portion in the lower clamp and the soft liner was in the upper clamp. The machine was operated at crosshead speed of 5mm/minute. The maximum load and the soft liner stretched length before failure was recorded for each specimen. The peel bond strength was calculated by the following formula.

$$\text{Peel bond strength} = \frac{F}{W}\left(\frac{1+\lambda}{2}+1\right)\left\{\frac{n}{mm}\right\}$$

The crosshead speed was same for all samples in order to standardize the procedure.

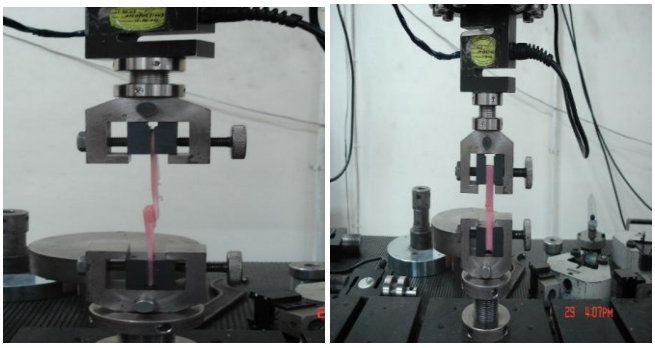

Fig 4: Universal testing machine Loyed used for Peel bond strength test at the speed of 5mm/minute

Results

Peel bond strength tests were carried out with a universal testing machine named Lloyed instrument. ten samples from each group were tested at a constant cross head speed of 5mm/min[12]. The tensile and peel bond strength were recorded. All data's were tabulated and statistical comparisons were made by one-way ANOVA variance and Turkey-HSD multiple range comparison test.

Statistical results of peel bond strength

Table 2: Description of peel bond strength statistic analysis (ANOVA) with 1% significant level

Sl. No	Group	Mean	SD	P- value
1	E	3.42[b]	0.19	<0.001**
2	F	4.32[c]	0.17	
3	G	1.06[a]	0.16	
4	H	1.14 [a]	0.07	

Note: 1. ** Denotes significant at 1% level

2. Different alphabet between the groups denotes significant at 5% level

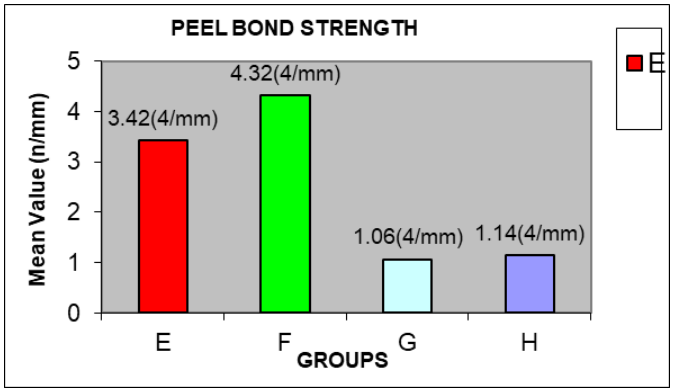

Fig 5: Comparision of groups by Tukey - HSD Test significant of at 5% level

Statistical analysis

- Overall comparison of groups was done using one-way analysis of variance (ANOVA) with significant at 1%. Level.
- Comparison with in the groups was done using multiple range tests Tukey-HSD test with significant at 5% level

Discussion

Resilient soft liners are widely used in prosthetic dentistry as an adjunct to removable prosthesis to restore the health of the

inflamed and abused denture supporting tissues [3, 4, 5] These materials are commonly used for patients with resorbed mandibular alveolar ridge, thin and nonresilient mucosal tissue, maxillofacial defect, patients unable to tolerate the hardness of heat-polymerized acrylic resin denture base and medically compromised individuals

Resilient soft liners are used to distribute functional loads and reduce the stress concentration on residual ridge and to make dentures more comfortable. The major drawbacks of soft liners is the lack of durable bond to the denture base [1, 2, 5]. The present study was under taken to evaluate the Peel bond strength of two commercially available soft liners G.C reline soft-Auto polymerized silicone soft liner & Coe-soft-Auto polymerized acrylic soft liner with heat activated acrylic denture base samples. The bonding ability of these resilient soft liners with pretreated and untreated surfaces of acrylic denture base was also evaluated in this study.

From the result of peel bond strength test, it was found that the silicone soft liner bonded to the treated surface of the denture base resin with methyl methacrylate for 180 seconds exhibited higher bonding ability than the silicone soft liner bonded to the untreated surface of the acrylic denture base [7, 8]. Mode of bond failure was also observed among the groups of the treated and untreated surface of the denture base. The pretreated surface of the denture base demonstrated primarily cohesive type of failure and the untreated surface shows primarily adhesive type of failure.

- The untreated surface of the acrylic denture base that is abraded with 320-grit silicone carbide paper showed scratches, pores and depressions.
- The pretreated surface of the acrylic denture base with methyl methacrylate for 180 seconds showed smoother surface texture.

The results of the present study revel that treating the acrylic denture base with methyl methacrylate improved the efficiency of bonding between a silicone-based resilient lining material and denture base. A notable limitation of this study is the use of only one type of silicone-based resilient lining material was deployed in the tests. Thus further elaborate study may be much useful to evaluate the effects of the denture base surface pretreatments on the bond strength of different silicone based soft lining materials.

Conclusion

Treating the acrylic denture base surface with methyl metha acrylate for 180 seconds significantly improved the bond strength of silicone based soft liner to the acrylic denture base. Considering the results of peel bond strength, the use of methyl methacrylate pretreatment for 180 seconds was found to be the most effective method to increase bonding ability of the silicone soft liner to acrylic denture base

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