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TO EVALUATE THE EFFECT OF ACCELERATED AGING ON TENSILE BOND STRENGTH OF TWO SILICONE AUTO POLYMERIZING SOFT TISSUE DENTURE LINERS WITH HEAT CURE ACRYLIC RESIN BEFORE AND AFTER AGING - AN IN VITRO STUDY

Dental Science

Dr. Insha Jan P.G Student, Department of Prosthodontics and Crown and Bridge Subharti Dental College, Swami Vivekanand Subharti University Meerut , U.P India

Dr. Sumit Makkar* Reader Department of Prosthodontics and Crown and Bridge Subharti Dental College, Swami Vivekanand Subharti University Meerut,U.P India*Corresponding Author

Dr. Deepesh Saxena Reader Department of Prosthodontics and Crown and Bridge Subharti Dental College, Swami Vivekanand Subharti University Meerut ,U.P India.

ABSTRACT

AIM: To evaluate the effect of accelerated aging on tensile bond strength of two silicone auto polymerizing soft tissue denture liners with heat cure acrylic resin before and after aging:In vitro-study. **MATERIALS AND METHODS:**For the purpose of this study,eighty samples were prepared. The test samples will be divided into four groups:Group 1 :Consists of 20 samples of heat cure acrylic resin (Travelon) with Mollosil soft tissue liner with no aging (CONTROL GROUP),Group 2: Consists of 20 samples of heat cure acrylic resin (Travelon) with Tokuyama soft tissue liner with no aging (CONTROL GROUP),Group 3 : Consists of 20 samples of heat cure acrylic resin (Tavelon) with Mollosil aged for 900 hours.Group 4: Consists of 20 samples of heat cure acrylic resin (Travelon) with Tokuyama aged for 900 hours. Tensile bond strength of each group was tested using universal testing machine. The results were statistically evaluated and compared.StatisticalAnalysis Used:ANOVA-F- test, Karl Pearsons correlation and unpaired't' test. **Result:** Comparison of mean bond strength among aged groups and control groups shows that there is no significant difference between the control groups and the aged groups.Conclusion: The mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama before and after aging was slightly greater than the mean tensile bond strength of auto polymerizing soft tissue denture liner Mollosil before and after aging.

KEYWORDS

INTRODUCTION

Soft tissue liners not only provide an even distribution of the masticatory loads on the denture bearing tissues but also avoids stress concentrations and also aids in the retention by engaging udercuts.[1]

Natural rubber was one of the earliest soft tissue liners to be used byTwichell in year 1969.Silicone based materials were introduced in 1958.[2,3]

In clinical practice the most desirable soft liners are plasticized acrylics and silicone rubber which are heat- or chemically-activated.[4] They can be short term or long term.The softness of these materials is due to the percentage of plasticizer content while as silicone elastomers consist of dimethyl-siloxane polymers, and have same chemical composition of silicone impression materials.[5]

According to Omer kutay[6] tensile test is the best method for the evaluation of bond strength of soft liners and acrylic resin denture bases as it verifies the strength required to rupture the bond, and allows for the comparison of different materials and polymerization methods. The saliva is being absorbed by the material which in turn solubilizes the plasticizer content of the soft tissue liners.[7,8]

Soft relining materials are extensively used in prosthetic dentistry, making it necessary to conduct research evaluating their mechanical and physical properties. Thus, the aim of this study was to evaluate the effect of aging on tensile bond strength between soft tissue liner and denture base resin.

MATERIALS AND METHODOLOGY:

The present study was conducted in the Department of Prosthodontics and crown and bridge, Subharti Dental College & Hospital, Meerut to evaluate the tensile bond strength of two silicone soft dentures liners with heat cure acrylic before and after aging.

ARMAMENTARIUM.

A. INSTRUMENTS AND EQUIPMENTS.

1.Special metal die.(figure 1)
2.Weather ommeter.
3.Universal Testing Machine.
4.Acryliser.
5.Hyadraulic press.
6.Micro motor.
7.Digitalcaliper.

B. MATERIALS

8. Heat polymerizing poly methyl methacrylate resin. (travelondentsply Co.) (figure 2)
9. Mollosil plus soft liner.(DETAX GmbH,Ettingen,germany) (figure 3)
10. Tokuyama soft liner. (Tokuyama Corp,Tokoyo, Japan) (figure 4).
11. Sandpaper 220 grit.
12. Distilled water.

Preparation of sample can be divided into:

1. Metal die fabrication.
2. Preparation of 80 acrylic blocks of heat polymerizing acrylic resin. (travelon)
3. Application of soft tissue liners of 3 mm between the two acrylic blocks.
4. Aging of the samples.

1) Metal die fabrication:

Stainless steel metal die which can be separated as three parts: upper, middle and lower part was made. Each part was 150 mm x 100mm dimensions .The middle part was 10 mm thick. There were four vertical slots (figure 5A)of the length 83 mm [40 mm (PMMA block)+3mm (soft liner)+ 40 mm (soft tissue liner)] cut through the middle member to act as moulds for packing acrylic resin. The width of the each slot was 10 mm so that the final specimen of dimensions 83mm x 10mm x10mm could be fabricated. In the centre of each vertical slot(figure 5B) suitable slidable slot is cut so that a metal separator (figure 5C)of dimension 3mm x 10mm x 10mm is fitted into it in the centre of the die which divides the slot into two equal halves of 40 mm each . For the ease of attaching soft liner the acrylic blocks on the each side of metal separator are marked as L and R, (FIGURE 5 D). Escape ways are also made on sides of the die for escapement of excess material(FIGURE 5 E). Die alignment pins at each corner in the upper and lower part and corresponding slots in the middle part are provided(FIGURE 5 F), they aid in re assembling of the die and then three parts of the die assembly will be tightened with the help of screws one on either side of the die(FIGURE 5G).

b) Preparation of acrylic resin blocks:

PMMA polymer and MMA monomer are mixed according to manufacturer's instructions. Once the mix reached dough stage, it was be packed in the moulds on the both sides of the metal separator and slowly pressure of the hydraulic press was increased. Polymerization of acrylic resin (Travelon) was carried out by sufficiently boiling clamped flask. The die was opened and the blocks were removed from the metal mould. Any sharp edges of acrylic resin were smoothened.Thus in all 8 blocks of acrylic resin blocks were cured at once time, and a total of 80 samples were prepared.

C) Addition of soft tissue liners.
The middle part of the die was placed on the lower part, acrylic resin blocks were placed into the corresponding slots Mollosil and Tokuyama soft liners was manipulated according to manufacturer's instructions and was placed in the 3 mm space between two PMMA blocks previously occupied by the metal separator maintaining the thickness of 3mm.The resins is left to set for 10 minutes and when all the samples were ready, the samples were taken out finished and excess soft tissue liner was trimmed with a B.P knife.

d) Aging of samples:
The samples were kept in weather Ommeter (UV and invisible light at 110 degree F) for 900 hours continuously at 90% relative humidity, within each 2 hours 18 minutes of distilled water spray will be given to samples which equals to 2 years of exposure in oral cavity.

Distribution of sample:
The test samples will be divided into four groups:
Group 1:Consists of 20 samples of heat cure acrylic resin (Travel) with Mollosil soft tissue liner with no aging (CONTROL GROUP)

Group 2:Consists of 20 samples of heat cure acrylic resin (Travelon) with Tokuyama soft tissue liner with no aging (CONTROL GROUP)

Group 3:Consists of 20 samples of heat cure acrylic resin (Travelon) with Mollosil aged for 900 hours.

Group 4:Consists of 20 samples of heat cure acrylic resin (Travelon) with Tokuyama aged for 900 hours(FIGURE 6).

Testing of samples:All the samples were tested for tensile bond strength on universal testing machine. The machine has a digital monitor which indicates the amount of force applied (FIGURE 7).

The samples were gripped vertically and firmly between upper and lower cross head jaws of the machine. Then tensile force was applied gradually at a crosshead speed of 5mm/min until complete debonding occurs. All the samples were tested in a similar manner till de bonding occurs completely and readings were recorded.The values are recorded in recorded in Mpa.The findings obtained were analyzed and subjected to statistical analysis.

RESULTS AND OBSERVATIONS:
From the tabulated observations and statistical analysis for the present study the following results can be drawn:

1. The mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama was found slightly greater than the mean tensile bond strength of auto polymerizing soft tissue denture liner Mollosil with heat cured acrylic resin before accelerated aging, but on statistical analysis, it was found to be non-significant.

2. The mean tensile bond strength of auto polymerizing soft tissue denture liner Mollosil before aging was found slightly greater than the mean tensile bond strength of of auto polymerizing soft tissue denture liner Mollosil after aging with heat cured acrylic resin, but on statistical analysis, it was found to be non-significant.

3. The mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama before aging was slightly greater than the mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama after aging with heat cured acrylic resin, but on statistical analysis, it was found to be non-significant.

4. The mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama after aging was slightly greater than the mean tensile bond strength of auto polymerizing soft tissue denture liner Mollosil plus after aging with heat cured acrylic resin, but on statistical analysis, it was found to be non-significant

DISCUSSION:
Adjusting prosthesis surfaces for the intimate fit in the patients mouth is a must, soft liners have been oftenly used for this purpose.Long-term resilient denture liner materials can maintain their resiliency for more than 30 days and can be used for up to 1 year, while short-term liners are recommended for use for up to 30 days.[9]

The bond failure is an important parameter, measurement and improvement of the bond between liner and denture base is very important.[10]

So it is imperative to check the tensile bond strength between the soft tissue liners and denture bases, to correctly evaluate and compare the longevity of the type of soft tissue liners to be used in the patient's mouth.[11]

NEERJA Mahajan, KussumDatta[12]who used tensile bond test in their study and stated tensile bond test mode used for measuring the bond strength was effective in evaluating and ranking the bond strength and they concluded that in tensile bond test the whole cross section of the specimen was under stress and can give accurate bond strength.

Another important parameter of this study is accelerated aging, which is done to evaluate the changes in the soft tissue liner but in a short duration of time. There is a change in mechanical properties of soft denture lining materials after some time.So to mimic this process,aging is done.Various methods of aging have been employed in past. Although the oral environment is more complex, but simulated aging treatment is useful for comparing different materials.[13]C. HEKIMOG LU & N. ANIL [14] used Weather-Ometer, instrument, used to mimic the ageing process and he concluded that the aging had no significant effect on the hardness of the soft tissue liners used.

C. N. Raptis and J. C. Knapp [15,16] also stated that the choice and method of surface conditioning do affect the ultimate tensile strength. The irregularities in the untreated stone mould surface may be transferred to the silicone during processing. At high elongation, the initiation and propagation of cracks to the point of rupture is more likely to occur at one of these irregularities.[17]Hence metal molds are better suited for the fabrication of samples. The testing parameters that play an important role in testing the tensile bond strength like the cross-head speed during testing. Jessica et al[5] stated that several cross-head speed values are reported in the literature for tensile tests but, a 5 mm/min was selected so the stress would build up at the bond interface and the relining material, exposing the reliner to elastic and plastic deformation until failure occurred[18].When the test is performed at a high crosshead speed, the stress builds up too quickly, and is concentrated on the reliner rather than being transferred to the interface, which would make the results dependent on the cohesive strength of the reliner, not on the bond strength to the acrylic resin hence, a speed of 5 mm/min was selected for our study.

A total of 80 specimens were divided into 4 groups two control groups and two aged groups and were designanted as Group 1,Group 2,Group 3and Group 4.The aging was done in weather Ommeter which equals to 2 years of exposure in oral cavity.

All the samples were tested in a similar manner and readings were recorded. The values were recorded in Mpa. The obtained data was interpreted and statistically analysed to evaluate the effect of accelerated aging on tensile bond strength of two auto polymerizing soft tissue denture liners with heat cure acrylic resin before and after aging. Data obtained were subjected to statistical analysis for inter group comparison using ANOVA-F- test, Karl Pear-sons correlation test and unpaired't' test.

Table 1:Reveals that the tensile bond strength was maximum in group 2 (Tokuyama without aging),followed by group 1 (Mollosil without aging), group 4 (Tokuyama with aging) & group 3 (Mollosil with aging). Above results are in support of the study conducted by Alla'a a M.Salloum[2] who stated that bond strengths of Mollosil plus soft tissue lining materials reduced significantly after immersion in distilled water and artificial saliva for 12 months.

The reduction in bond strength was attributed to swelling and stress build-up at the bond interface, or changing the viscoelastic properties of the soft lining materials after immersion which is in accordance to other studies[19,20,21,1,8].It may be due to the complex nature of the bonding phenomenon. This result also Indicated that the strengths of soft lining materials were more than their bond strengths[11].The mean score of tensile bond strength of group 1 and group 2 are 45.95 and 51.90 mpa

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respectively. It was concluded that the tensile bond strength of Group 1 (Mollosil without aging) is less thangroup 2 (Tokuyama without aging).GRAPH 4. This finding agreed with those of earlier reports by Amin et al [22]and Polyzois [21] who stated that water storage reduced the bond strength of resilient liners,which is in agreement to our present study.

The mean average score of tensile bond strength of group 1 (Mollosil without aging), and group 3 (Mollosil with aging) GRAPH 5 are 45.95 and 41.60 mparespectively. In other words, the tensile bond strength is greatly affected when effects of aging are compared before and after within the same group hence we have drawn a conclusion that aging reduces the tensile bond strength.

The mean score of tensile bond strength of group 2 (Tokuyama without aging), and group 4 (Tokuyama with aging) are 51.90 and 43.65 Mpa respectively (graph 6) and it is concluded that the aging has a significant effect on the tensile bond strength and this was supported by the study conducted by Grzegorz Chladek, Jaroslaw Zmudzki and Jacek Kasperski[3] who stated that the tensile bond strength decreases with increasing aging time in various solutions, in association with the swelling and altered stiffness of the altered materials and formation of fissures and internal stress at the lining denture interface of the soft tissue denture liners.The other studies which were in line with our present study includeNuranYanikotlu and SaipDenIzoglu[23],AyseMese and Kahraman G Guze[11] and Gregory L. Polyzois. [21]

On the contrary Takahasghi Jessica mie Ferreira et al [5] stated that silicone based soft tissue liners presented higher values for tensile bond and the specimens were not affected by the aging of the samples. The same results were given by A.K. Aydin et al [24] and Craig and gibbons.[10]

It is also found that Tokuyama has a greater tensile bond strength before and after aging than Mollosil soft tissue denture liner.

Thus, from the present study it was concluded that the tensile strength between soft tissue denture liner and heat cured poly methyl meth acrylate reduced (Tokuyama >Mollosil), but is statistically insignificant at .05 level of significance i.e, (p>.05), as there is no chemical bond between the silicone soft liner and PMMA and the bond is adhesive mostly. Hence, with aging the adhesive swells up and there is stress build-up at the bond interface, and hence the bond strength is decreased after aging.

CONCLUSION:

Within the limitations of the present study and on the basis of the results obtained the following conclusions were drawn:

1. The mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama was found slightly greater than the mean tensile bond strength of auto polymerizing soft tissue denture liner Mollosil with heat cured acrylic resin before accelerated aging, but on statistical analysis, it was found to be non-significant .
2. The mean tensile bond strength of auto polymerizing soft tissue denture liner Mollosil before aging was found slightly greater than the mean tensile bond strength of of auto polymerizing soft tissue denture liner Mollosil after aging with heat cured acrylic resin, but on statistical analysis, it was found to be non-significant.
3. The mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama before aging was slightly greater than the mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama after aging with heat cured acrylic resin, but on statistical analysis,it was found to be non-significant.
4. The mean tensile bond strength of auto polymerizing soft tissue denture liner Tokuyama after aging was slightly greater than the mean tensile bond strength of auto polymerizing soft tissue denture liner Mollosil plus after aging with heat cured acrylic resin, but on statistical analysis, it was found to be non-significant.

Hence, it can be concluded that aging significantly reduced the tensile bond strength of silicone soft tissue liners after aging but is statistically insignificant at .05 level of significance and tensile bond strength of Tokuyama reline 2 soft tissue liner is higher than tensile bond strength of Mollosil after aging but is statistically insignificant at .05 level of significance.

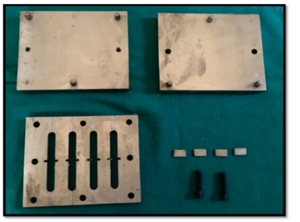


FIG 1 – Special Metal Die.

FIG 2- Dentsply Heat cure denture base resin.

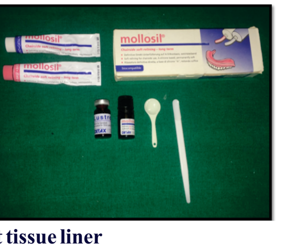


FIG 3- Mollosil soft tissue liner

FIG 4 – Tokuyama soft tissue liner.

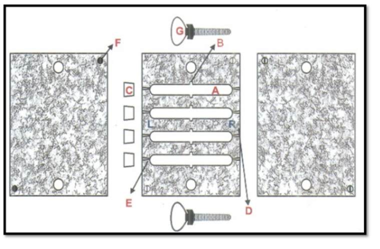


FIG 5 – Diagram showing parts of the metal die.

A – Vertical slot to act as a Mould (83 mm x 10 mm x 10 mm).
B – Slidable Slot.
C – Metal Separator.
D – Markings of L & R Marked.
E – Escape ways.
F – Pin for Alingment.
G – Screws for tightening.

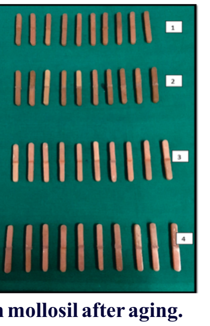


FIG 6 – 1. Samples with mollosil after aging.

2. Samples with Tokuyama after aging.
3. Samples with Tokuyama without aging.
4. Samples with Mollosil without aging.

FIG 7- Specimens ready for testing in Universal Testing Machine.

Table 1. Mean , S.D., Median, Maximum & Minimum Scores Of Tensile Bond Strength (in MPA) For Four Groups

S.NO.	GROUP 1	GROUP 2	GROUP 3	GROUP 4
1	50.00	58.00	45.00	45.00
2	56.00	60.00	40.00	45.00
3	45.00	55.00	45.00	50.00
4	52.00	58.00	48.00	52.00
5	40.00	45.00	45.00	40.00
6	40.00	60.00	40.00	42.00
7	40.00	55.00	30.00	45.00
8	49.00	53.00	52.00	43.00
9	45.00	51.00	55.00	42.00
10	30.00	49.00	45.00	30.00
11	51.00	52.00	25.00	39.00
12	45.00	49.00	22.00	45.00
13	45.00	55.00	23.00	42.00
14	45.00	50.00	45.00	34.00
15	45.00	54.00	45.00	37.00
16	50.00	45.00	52.00	38.00
17	40.00	42.00	32.00	40.00
18	51.00	53.00	45.00	52.00
19	50.00	40.00	43.00	62.00
20	50.00	54.00	55.00	50.00
MEAN	45.950	51.900	41.600	43.650
S.D.	5.916	5.628	10.096	7.169
MEDIAN	45.00	53.00	45.00	42.50
MAXIMUM	56.00	60.00	55.00	62.00
MINIMUM	30.00	40.00	22.00	30.00

Table: 2- Comparison For Tensile Bond Strength (In MPA) Between Different Pair Of Groups (By Unpaired"t" Test)

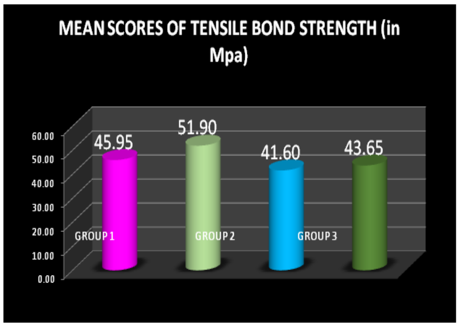
S. NO.	Pair Of Groups	P- Value (by Unpaired"t" Test/independent "t" Test	% Difference In Tensile Bond Strength	Significance
1	Group 1 & Group 2	.2912** (P>.05)	+12.95%	No Significant Difference
2	Group 1 & Group 3	.5876** (P>.05)	-9.47%	No Significant Difference
3	Group 2 & Group 4	.4896** (P>.05)	-15.90%	No Significant Difference
4	Group 3 & Group 4	.3165** (P>.05)	+4.93%	No Significant Difference

Table 3- Comparsion For Tensile Bond Strength (IN MPA) Among Different Groups Simultenously At A Time(one Way Anova-f- Test)

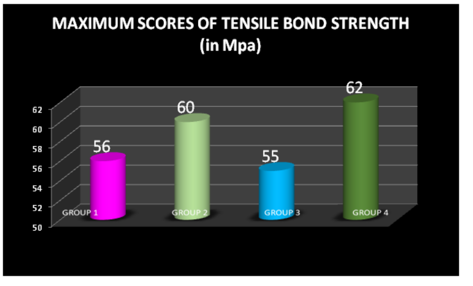
Source Of Variation	SS	DF	MS	F	P-Value	F CRIT
Between Groups	589.85	3	196.6166	2.3283	0.1024**	2.724944
Within Groups	6418.01	76	84.4475		P>.05 (not Sig.)	
Total	7007.86	79				

Table-4: KARL Pearsons Correlation Cofficient's Among Different Groups For Tensile Bond

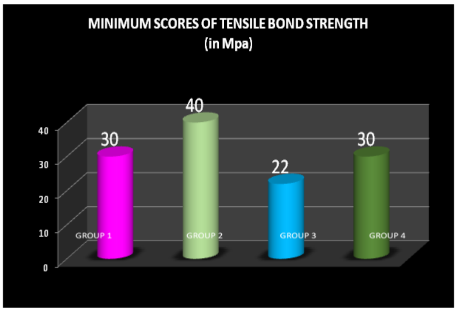
	Group 1	Group 2	Group 3	Group 4
Group 1	1			
Group 2	0.2559** (+ VE Correlation)	1		
Group 3	0.1574**(+ VE Correlation)	0.0104** (+ VE Correlation)	1	
Group 4	0.5431*(+ VE Correlation)	0.0265** (+ VE Correlation)	0.0859** (+ VE Correlation)	1



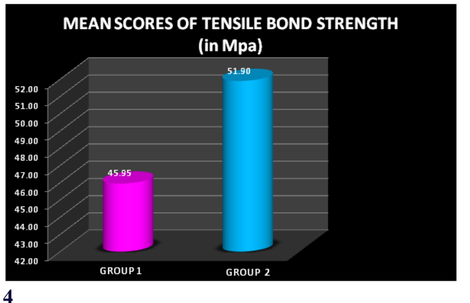
GRAPH 1.



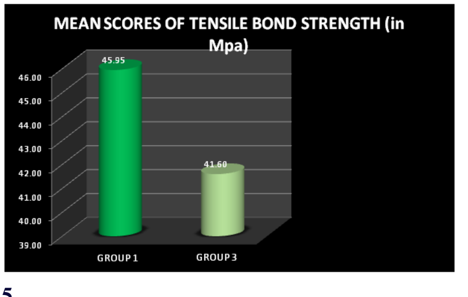
Graph 2



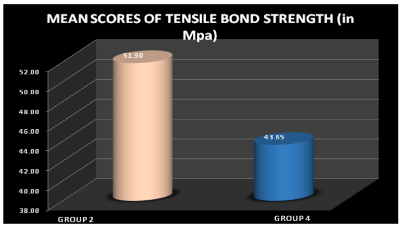
Graph 3



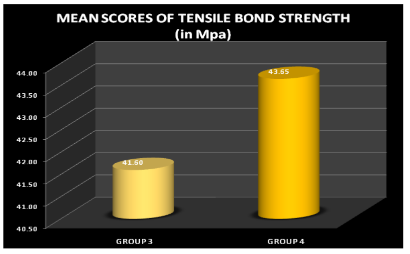
Graph 4



Graph 5



GRAPH 6



GRAPH 7

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