

# The change of temperature on the shear strength of permanent soft-liner on acrylic resin

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**ABSTRACT**

The characteristics of dental material such as solubility and water resorption, the use of adhesive, storage condition or used as thermo cycling or elevated-temperature are factors that can effect bond strength. The purpose of this study was to investigate the change of temperature on the shear strength of permanent soft liner on acrylic resin. Twenty-four specimens were divided into 3 groups and immersed in water at: 5 °C, 37 °C and 55 °C. Autograph AG 10 TE Shimadzu was used to determine the shear strength. The statistical test (ANOVA and LSD); showed that there were significant differences between temperature groups. The shear strength of 37 °C was higher than the temperature of 5 °C and 55 °C.

**Key words:** temperature, shear strength, permanent soft liner, acrylic resin

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**INTRODUCTION**

Making acrylic removable denture requires soft liner material to overcome post-denture insertion problem such as denture unsteadiness due to the resorption of alveolar bone, and relief the traumatic pain. It is a cushion between the denture base and the gingival underneath. The aim of using soft liner is to decrease the denture mastication force and distribute it to the underneath tissue.<sup>1,2</sup> Soft liner is a soft, elastic, and spongy material which is used to line all or part of denture surface.<sup>3</sup> It could avoid the pressure on one spot which could traumatized the underneath tissues.<sup>2-4</sup> This material has been widely used for more

than a century and the first soft liner was made of natural rubber. In 1945, polyvinyl plastic, a synthetic resin was utilized as soft liners and in 1958 silicon elastomer was introduced.<sup>4</sup> Hamada *et al.*<sup>5</sup> divided soft liner materials as follows (Figure 1).

The main problem often encountered in permanent soft liner usage was the change or increased temperature during utilization which affected the bonding of soft liner and acrylic denture.<sup>3</sup> There is a possibility that the patients had drinking habit with specific temperatures either cold or hot. The aim of the research was to examine the effect of different immersed temperature on the shear strength of permanent soft-liner self-cured on the acrylic resin denture base.

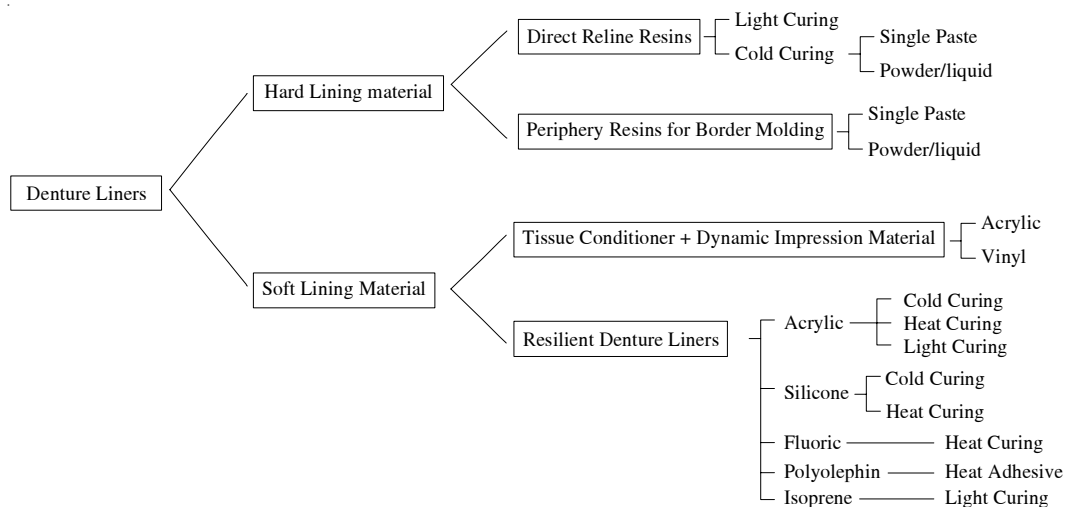
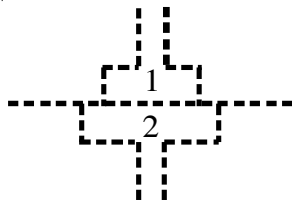


Figure 1. Denture liners material scheme.<sup>5</sup>

## MATERIALS AND METHODS

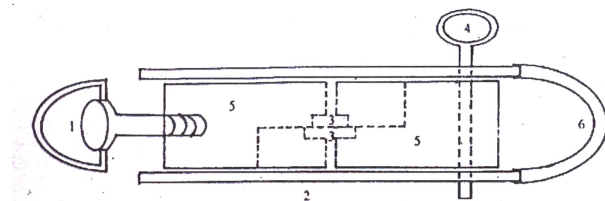
The research was done at Prosthodontics Department of Airlangga University Faculty of Dentistry and at Basic Laboratory of Airlangga University. Materials used were heat-cured acrylic (ADM brand, America) permanent soft liner (GC Reline Extra soft, Japan), sterile aquadest, red paraffin (Cavex, Holland), hard gypsum (Moldano, Bayer, Jerman), soft gypsum (Super France) cellophane plastic, and couls mould seal. Instruments used were a refrigerator for the 5 °C temperature (Toshiba, Japan); waterbath for the 55 °C (Memert, Japan); Autograph AG 10 TE. (Shimadzu, Japan) to measure shear strength with its modification apparatus; porcelain pot to mix acrylic, metal cuvette, bench press hydraulic, vibrator (Yoshida, Japan), digital stick thermometers, and becker glass.

The specimen was made from a master model of a metal plate which was specifically designed, cylinder formed, with 8 mm diameter, 2 mm thickness, and it had a hole in the middle of the cylinder with the diameter of 1 mm (Figure 2).



**Figure 2.** Blueprint of specimen final form.  
Note: 1. Permanent soft liner, 2. Acrylic resin

Afterwards, specimen as a result of curing process was cleaned and dried to remove dirt or fat, and assisting instrument was installed. Permanent soft liner mixed according to manufacturer's manual was inserted to other pair's assisting apparatus. Then, both surfaces were bonded and fixated for 5 minutes (following manufacturer's manual) (Figure 3). Specimen was released by pushing their stalk holders.



**Figure 3.** Profile plane of an assisting instrument.

- Note:
1. Grooved and hooked stalk
  2. Holder tube
  3. Specimen location
  4. Fixating dowel
  5. Pair tube
  6. Metal hook

Each group consisted of 8 samples and each was immersed in aquadest with the temperatures of 5 °C, 37 °C and 55 °C. The sample immersion was done for two days which was equal to 1 year utilization, assuming that the patients drank twice a day, every time they drank was in 4 minutes duration, in one year (365 days) =  $365 \times 8$  minutes = 2920 minutes = 2920 : 1440 = 2 days in body temperature 37 °C, cold 5 °C or warm 55 °C, the immerse aquadest was replaced every day.<sup>6</sup>

Using Autograph AG 10 TE Shimadzu, the shear strength test was examined by way of: adapted-to-template specimen was precisely positioned so that the assisting instrument could be sealed without any gap. A pair of assisting instruments was put into holder tube, until the fixated dowel could lock the hook at the upper end, while the metal holder at the lower end could be clamped to the measuring machine. The machine was revived; there was a pulling ties/bonding on assisting instrument made of metal brass. The magnitude of shear strength was calculated with shear strength formula:  $(\pi) = F/dh$ .

F = unloaded strength to release specimen

d = specimen diameter

h = specimen thickness (mm)

The results data was tabulated and analyzed with Two-Way ANOVA, after a normal distribution test with Kolmogorov Smirnov was done. Multiple comparisons were carried out with LSD.

## RESULT

Shear strength mean score was presented in Table 1.

**Table 1.** The mean score ( $\bar{X}$ ) and Standard Deviation (SD) of a statistical test of permanent soft liner shear strength on the basis of acrylic dentures, after immersion in sterile aquadest with temperatures 5 °C, 55 °C, 37 °C observed for 2 days (kg/mm<sup>2</sup>)

Temperature	N	Mean	Standard Deviation
5 ± 1 °C	8	47.01	1.96
55 ± 1 °C	8	50.71	1.86
37 ± 1 °C	8	54.43	2.51

Prior to statistical test, a normal distribution test Kolmogorov Smirnov was carried out with  $p > 0.05$  and the result showed that samples were in normal distribution. Afterwards, Two-Way ANOVA test gave result  $p = 0.01 < 0.05$  showed a significant difference. Later, an LSD test was done as presented in Table 2.

**Table 2.** Result of LSD test of temperature groups during two days immersion ( $p < 0.05$ )

Immersion temperature	5 °C	55 °C	37 °C
5 °C	-	0.01*	0.01*
55 °C	0.01*	-	0.01*
37 °C	0.01*	0.01*	-

Note: \*: significant difference was present

Table 2 showed the differences between immersion groups 5 °C and 55 °C where  $p = 0.01 < 0.05$ , meaning that there was a significant difference. Also, in immersion group with 5 °C and 37 °C,  $p = 0.01 < 0.05$  there was a significant difference. And in immersion group with 37 °C and 55 °C,  $p = 0.01$  showed a significant difference.

## DISCUSSION

The statistical analysis (Table 2) revealed a significant difference of shear strength ( $p < 0.05$ ) in groups of 5 °C, 55 °C and 37 °C. The result of shear strength of group 5 °C showed the lowest value compared to group 55 °C and 37 °C. Several possible reasons for the low shear strength from group  $5 \pm 1$  °C were: 1) the difference of heat expansion coefficient between acrylic denture basis material (PMMA) and silicon elastomer. Acrylic heat expansion coefficient was  $81 \times 10^{-6}/^{\circ}\text{C}$ ,<sup>7</sup> while the heat expansion coefficient of silicon elastomer was  $190 \times 10^{-6}/^{\circ}\text{C}$ .<sup>8</sup>

This was in accordance with Combe<sup>7</sup> and Al-Athel and Jagger's<sup>9</sup> opinions that having a different heat expansion coefficient would result in making temperature enable to influence the dimension change of a material; 2) sudden material shrinkage, causing micro leakage in the interface area.<sup>9-10</sup> for the  $55 \pm 1$  °C group (Table 1), in general it had lower shear strength compared to control group ( $37 \pm 1$  °C). Besides the difference of two bonded materials with different heat expansion factors, another possibility might be caused by silicon elastomer which experienced expansion in high temperature. This was in accordance with Wright's<sup>11</sup> that although silicon's transition temperature was very low, in sensitive to temperature's change, yet at 40 °C it already decreased the bonding strength because of simultaneous expansion in which cause water resorption would occur to filler contents. Thus, water could directly enter the bonding area, causing swelling and pressure to the interface that decreased the bonding strength.<sup>12,13</sup> The material swelled and the interface was pressured, or it could also caused by elasticity change of the resilient

lining, which produced material stiffness and external load flow towards the bonding.<sup>12,13</sup>

The research out come should be informed to the patients that low ( $5 \pm 1$  °C) and high ( $55 \pm 1$  °C) temperatures could decrease permanent soft liner self-cured shear strength. Soft liner material low shear strength could bring about a failure in bonding and shorter duration of utilization. This condition was likely to generate bacterial growth, plaque, and calculus forming, so that evaluation of soft liner changes must be done correctly or even periodical soft liner changes.<sup>12</sup> From the result of the influence of temperature to the shear strength of permanent soft liner on acrylic resin, a conclusion was derived that there was a significant difference of shear strength among immersion groups in sterile aquadest of 5 °C, 55 °C and 37 °C, whereas the shear strength of the low temperature (5 °C) and high temperature groups (55 °C) were lower than the control group (37 °C).

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