

Influence of Different Ways of Treatment on Hardness of Soft Relining Materials

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Abstract: *Statement of problem: Hardness of soft relining materials is influenced by different solutions, coatings and physical procedures. Purpose: To estimate the significance of different treatment procedures to the change in hardness of SRM. Materials and methods: A total number of 360 test samples were made and divided into 12 groups. Results: The highest values of hardness belong to Mollosil, covered with sealer after thermocycling. The VPS materials are less affected by different ways of treatment. Alcohol has a deteriorating effect to the SRM, especially the PMMA ones. Conclusion: After application of a sealer the hardness of the test samples increases at an average of 2 max 3 units in Shore's scale (for both of the testing groups). The sealer protects the SRM from disintegration, that is way it is strongly recommendable to use it in order to elongate the durability of these materials.*

Keywords: Soft relining materials, Shore A hardness

1. Introduction

Soft relining materials (SRM) are very useful in overcoming difficult cases with: severely atrophied alveolar ridges, covered with thin mucosa, undercuts, painful zones, patients suffering xerostomia etc. The SRM can distribute the masticatory forces and reduce the tension in this area. Using the so called "two-layer dentures" can become a powerful weapon in overcoming such obstacles.

Despite all their advantages, these materials have a lot of disadvantages as well. Some of them are: change of colour, increasing hardness, problems with the attachment to the denture base, specific odour, etc [1 – 5]. Because of this a lot of dentists even refuse to use SRM in their practices and feel reluctant to offer their patients such treatment.

The SRM must require certain properties (medical, biological, physical, mechanical, chemical etc). Unfortunately nowadays there is no such product on the market.

The aim of this investigation is to estimate the significance of different treatment procedures to the change in hardness of SRM.

2. Materials and Methods

To fulfil this investigation, a special press-shape was designed, which enabled us to make test samples with particular size: 30x20x2.5 mm (fig. 1 and 2). A total number of 360 test samples were made and divided into the following 12 groups:

- 30 samples of Tissue Conditioner - sealer free (control group)
- 30 samples of Tissue Conditioner - treated with sealer
- 30 samples of Tissue Conditioner - placed for 48 hours in 40% ethyl alcohol -(sealer free)
- 30 samples of Tissue Conditioner - placed for 48 hours in 40% ethyl alcohol -(treated with sealer)
- 30 samples of Tissue Conditioner - submitted to thermocycling - (sealer free)

- 30 samples of Tissue Conditioner - submitted to thermocycling - (treated with sealer)
- 30 samples of Mollosil - sealer free (control group)
- 30 samples of Mollosil - treated with sealer
- 30 samples of Mollosil - placed for 48 hours in 40% ethyl alcohol - (sealer free)
- 30 samples of Mollosil - placed for 48 hours in 40% ethyl alcohol - (treated with sealer)
- 30 samples of Mollosil - submitted to thermocycling - (sealer free)
- 30 samples of Mollosil - submitted to thermocycling - (treated with sealer)



Figure 1: Disassembled press-shape



Figure 2: Assembled press-shape

For the purpose of this study, we used a device (fig. 3), that fulfils the requirements of the American Society for Testing and Materials (ASTM) [6], specification D-2240 ASTM, with the assistance of Shore's Durometer to determine the change in hardness in the different test samples.



Figure 3: The device according to the requirements of ASTM

A typical shortcoming for the SRM is that after certain period of time, these materials lose their softness and become brittle [7; 8]. Using Shore's durometer, we were able to determine the changes in hardness before and after controlled aging of the test samples by the means of thermocycling, as well as the influence of ethyl alcohol. The effect of the applied sealer was also taken under consideration. Shore's test is usually performed as a penetration of a probe inside rubber with constant load of 1 kg. The device is placed vertically and pressed against a test sample. Every time the probe penetrates into a depth of 0.0254 mm, it equals a single unit from Shore's scale. The ultimate value of hardness is obtained by the depth an indentation in the test sample. The data are being measured 1 sec after reaching a full contact with the help of a stopwatch. A total number of 5 penetrations were made for every test sample with 6 mm distance from each other. This distance in ambient temperature is in conformability with the requirements of ASTM, specification D-2240 (fig. 4).



Figure 4: A test sample with indentations for measurement

The tests were made 24 hours after polymerization (for the control group), after thermocycling and exposure to 40% of ethyl alcohol solution, respectively. From the device' menu, we set 5000 cycles in the temperature range of 5-55⁰ C. The time of dipping into the pod with distilled water is 1 min, with 30 sec gap between the dippings (fig. 5). Between the tests all the test samples were stored in distilled water and right before testing they were dried with blotting paper.



Figure 5: The thermocycling device

3. Results and Discussion

We calculated that the requisite number of test samples for obtaining 95% confidence interval is 27.564. After the correction we figured out the requisite number of test samples for obtaining 80% power of ANOVA analysis are 29. Finally 30 test samples in each group were made.

Table 1: Average values and standard deviation of the test samples according Shore A

Groups	Material	Number of samples	Average value	Deviation	Min. value	Max. value
1a	T. C. treated with sealer	30	17.250	0.907	15.000	18.500
1b	T. C. treated with sealer in ethyl alc.	30	7.817	0.914	6.000	9.000
1c	T. C. treated with sealer after thermocycl.	30	21.733	0.728	20.500	23.000
2a	Mollosil treated with sealer	30	30.317	0.748	29.000	31.500
2b	Mollosil treated with sealer after thermocycl.	30	33.633	0.798	32.500	35.000
2c	Mollosil treated with sealer in ethyl alc.	30	27.700	0.664	27.000	29.000
3a	T. C. sealer free (control group)	30	13.000	0.587	12.000	14.000
3b	T. C. sealer free in ethyl alc.	30	4.333	0.531	3.500	5.000
3c	T. C. sealer free after thermocycling	30	16.767	0.583	16.000	17.500
4a	Mollosil sealer free (control group)	30	27.350	0.778	26.000	29.000
4b	Mollosil sealer free in ethyl alc.	30	23.533	0.840	22.000	25.000
4c	Mollosil sealer free after thermocycling	30	29.783	0.583	29.000	31.000

For a better visualization, the results of the average values and their ratio are shown in diagram 1.

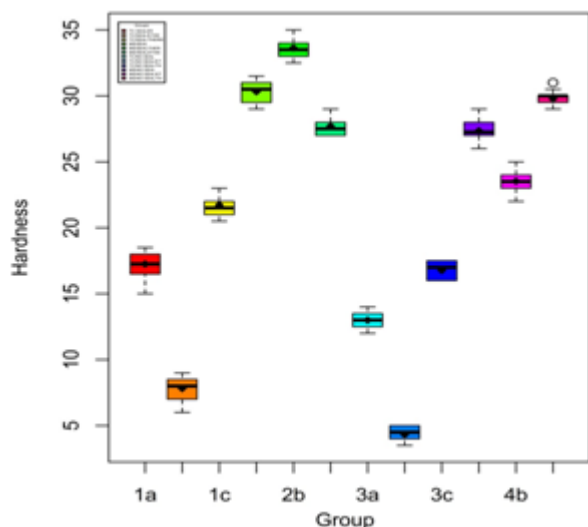


Diagram 1: Obtained ratio of the values from the hardness

From the gathered data, it is evident that the highest hardness belongs to Mollosil, covered with sealer after thermocycling. These results are similar to the results of the material in sealer free state and to the control group. The study found that ethyl alcohol does not cause serious softening of the VPS material, although the use of sealer has a positive influence and keeps the initial levels of hardness.

Tissue Conditioner is a softer material than Mollosil, but its hardness may vary and depends on the powder/liquid ratio, which according to manufacturer's instructions is 1:2. Nevertheless, we should consider the fact that the values of initial hardness of Tissue Conditioner (control group) is twice lower than Mollosil (control group) in Shore's scale, i.e. the material is softer. The lowest values of hardness are measured after placing the material in ethyl alcohol that causes disintegration of the material. There are two reasons to choose this particular concentration of ethyl alcohol: Spirit is an ingredient seen in most of the cleaning and disinfectant products for dentures, as well as in mouthwash products. The majority of all high alcoholic drinks contain approximately 40% ethyl alcohol. Patients should consider this fact as the systematic intake of liquors might be a cause of disintegration of the relining material or its substantial softening. The sealer increases the hardness of the test samples of Tissue Conditioner even more in comparison to the silicones. This is due to the fact that the sealer covers the acrylic surface, preventing the loss of plasticizers on one side and incoming of fluids on the other. This is how soft relining materials (SRM) keep their hardness. In this way less internal stress is being generated in the interface between the denture base and the relining material and the bond between them remains stronger. Higher hardness values after sealer application before submerging into ethyl alcohol shows that sealer has a protective effect. This is the reason for us to suggest that, its application will provide clinical durability of SRM.

To check the significance of the difference, and to ensure that the difference is not due to intergroup divergence we applied ANOVA analysis, shown in table 2.

Table 2: Variational analysis

	Degrees of freedom	Sum of squares	Average of the squares	F	P<0.001
Group	11	28894.64	2626.79	4890.75	0
Residual	348	186.91	0.54		

This analysis shows that there is a difference between the groups, but it does not specify between which ones. To compare the groups between each other we used Tukey test. Results are shown in diagram 2.

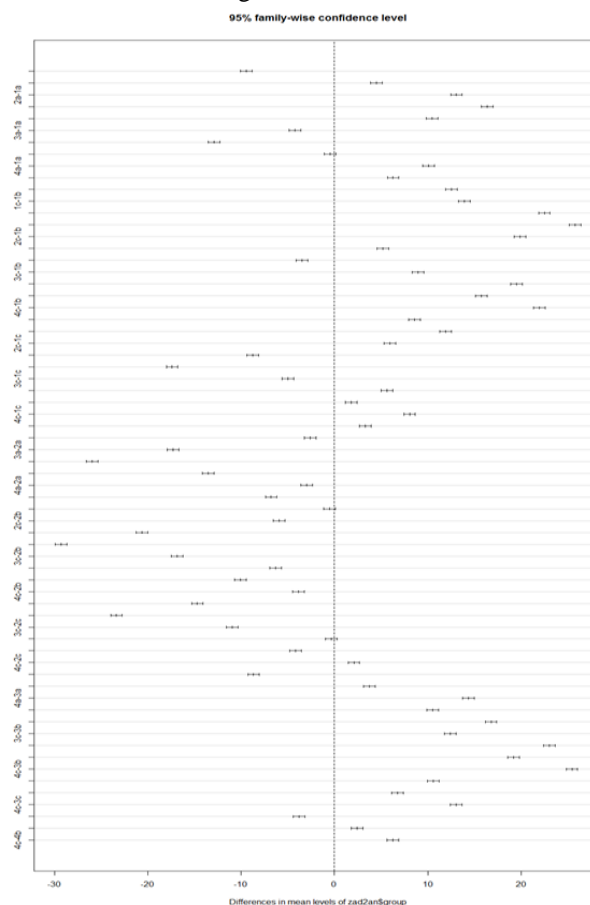


Diagram 2: Comparison between the groups using Tukey test

The results obtained from the current investigation are in consideration of other authors [9; 10; 11; 12].

4. Conclusion

Differences are present between each and every material, as well as after a certain treatment (with ethyl alcohol and thermocycling). It is clear that after the application of a sealer the hardness of the test samples increases at an average of 2 max 3 units in Shore's scale. Thermocycling also causes increase of hardness in both groups - Tissue Conditioner and Mollosil, but higher with Tissue Conditioner. It is due to a loss of plasticizer, because materials based on VPS do not contain plasticizer and in their case there is less change in hardness. Ethyl alcohol has a disintegrating effect on SRM, especially the acrylic ones. The sealer has positive effect on both groups, it has protective properties and prevents the incoming agents from outside environment to penetrate.

Within the limitations of this study we can conclude that it is recommendable, even necessary to use a sealer. In case the manufacturer does not supply one, a proper analogue must be found. Although the PMMA and VPS are the two major groups of SRM (most commonly used), it will be beneficial if other groups of materials be included in the investigation for a future comparison.

5. Abbreviations

SRM – Soft relining material
VPS – Vinyl Polysiloxane

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