The Effect of Surface Coating on Softness of Two Kinds of Tissue Conditioners

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ABSTRACT

Introduction: One of the limitations of tissue conditioners (TC) is gradual hardening of the material in a short time period after insertion in the mouth, due to the loss of their viscoelastic properties. The aim of this study was to determine the softness of two different tissue conditioners with and without the Monopoly coating.

Methods and Materials: In this experimental study, Acropars and Viscogel tissue conditioners were examined. Ten samples of each tissue conditioner were prepared, using 3×20 mm (h×d) aluminum cylindrical molds. Half of the samples in each group were coated with Monopoly coating. Samples were kept in a water bath at 37ºC and the hardness of their surfaces was measured (in Shore-A) after 1, 3, 7, 14, and 28 days. The results were analyzed using t-test, Multivariant ANOVA and Tucky posthoc test.

Results: There were significant differences in hardness ($P < 0.05$), comparing, the coated and uncoated Acropars ($p=0.000$), the coated and uncoated Viscogel ($p=0.000$), the coated Acropars and uncoated Viscogel ($p=0.000$), the coated Acropars and coated Viscogel ($p=0.036$), and the uncoated Acropars and coated Viscogel ($p=0.000$) samples.

Discussion: It was found that the hardness of all of the samples increased with time. For both tissue conditioners, the hardness of samples with coating was higher than of those without coating. This indicates that the Monopoly coating dose not protect the softness of these two tissue conditioners.

Key words: Tissue Conditioner, Coating, Monopoly, Softness.

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Introduction

Tissue condisioners (TC) are soft, resilient materials used to treat inflamed, irritated, and distorted tissue and to save its function. They are also used as interim reliners and during the healing phase after implant placement. Tissue conditioners are made of acrylic resin that is set to form a viscoelastic gel without undergoing cross linking reaction. So it acts as a resilient cushion under the dentures. The resultant liners are considered as short-term soft liners or tissue conditioners.There are some chemically activated soft liners,heat activated materials generally are more durable and may be as considered long-term soft liners[1].Limitation of the TCs results from the effects of oral environment on their physical properties[2]. The wet environment of the oral cavity allows the ethanol and ester plasticizers leach into saliva and water is then absorbed by the polymeric phase of the gel.The loss of plasticizer leads to gradual hardening of TCs and affects its properties such as surface integrity and viscoelastisity and decreases its useful life time [3, 4]. Few minutes after mixing, the tissue conditioners become viscouse enough to be inserted in mouth. The final gelation takes about 15-20 minutes. The gel phase initially shows a plastic behavior, however it gradually losses this property and an elastic behavior is observed finally [5].

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The use of coating is one of approaches to save surface integrity and softness and to reduce microorganisms' growth in tissue conditioners. A recommended coating is Monopoly, a material composed of polymethylmethacrylate powder and its monomer (1/10 w/w) with thermal polymerization method [6, 7]. It is reported that the coating of TC with Monopoly could extend its life time to 30 days and sometimes to one year, due to protecting the material surface (8, 9), saving the flexibility of temporary layer for a long time period, and inhibiting the microorganisms' growth [9]. Dominguez found that the TCs coated with monopoly have lost alcohol but did not absorbed water invitro, and there was no loss of plasticizer over the 30 days time period [7].

Gronet suggested that the resiliency of the TC which is coated with Palaseal or Monopoly is improved, however the different TCs show variable reactions to the coating. This may be due to different adhesion of coating layers to the TC and difference in the composition of TC materials (e.g. alcohol and plasticizer percents) [10].

Malmstrom found that the application of Monopoly and Permaseal coating on GC tissue conditioner, significantly reduced the surface deterioration and the loss of TC softness. Coated permaseal remained soft over the length of the study [6]. Although the literatures suggest that the coating protects the softness of TC, however there is an idea that this may depend on the composition of the TC such as the kind and amount of alcohol and plasticizer, as well as the particle size of polymer powder, and so on. The purpose of this study was to examine the effect of Monopoly coating on softness of two tissue conditioner materials at different times.

Methods and Materials

In this experimental research, two different commercial TCs were used: Acropars which is made up of powder: ethylmetacrylate copolymer, liquid: ethanol and plasticizers(Marlik Medical Industries Co., Tehran, Iran) and, Viscogel which is madeup of powder: polymethylmetacrylate, liquid: phthylbutylglycolate and ethanol (Dentsplay Detrey GmbH, Konstanz, Germany).

Ten disc samples were prepared based on manufacture instruction from each TC (Viscogel:P/L=3gr/2.2ml, 30" mixing time) (Acropars: P/L=1/4 using measuring scale), using 3×20 mm (h×d) aluminum cylindrical molds and two glass sheets. Monopoly coating was prepared by mixing 1 part of polymethylmetacrylate powder (Acropars:Marlik Medical Industries Co., Tehran, Iran)with 10 parts of monomer in a cap inserted in a boiling water bath for 8-10 minutes.

Half of the samples in each group were coated with Monopoly coating. The samples were coated by a paintbrush three times. There were 3-5 minutes between each coating layer application. Then, all samples were maintained in an incubator (Pars Azma, Tehran, Iran) at 37ºC in four glass beakers, filled with water. The hardness of sample surfaces was measured digitally in 5 time intervals after 1, 3, 7, 14, and 28 days, using Shore-A durometer (TH 200-Time Group Co., Germany). The measuring was repeated 3 times for each sample and the average value was reported as the hardness at corresponding time. The samples were returned back to the water at maintaining condition after any hardness measurement.

The results were analyzed using t-test to evaluate the influence of the kind of TCs. All of the results at different times were also analyzed using Multivariate ANOVA and Tucky Posthoc test.

Results

The t-test showed that the mean hardness of coated Acropars and Viscogel samples are significantly different at the measuring times ($P<0.036$).The results showed that the hardness of the samples increased. The results also indicated that the hardness of coated Acropars is significantly less than that of coated Viscogel at the measuring times ($P<0.036$).

There is no significant difference between the mean hardness of uncoated Acropars and uncoated Vicsogel samples ($P > 0.05$).

ANOVA test was used in order to clarify the effects of various variables on the hardness of 20 prepared samples (table 1). A Multivariate ANOVA was used to analyze the influence of each factor.

All of the factors except the TC have significant influence on the hardness of samples ($P<0.05$). The effects of TC and coating are more analyzed using Tucky Posthoc test (Table2).

Figure 1 indicates the changes of hardness in different samples during one month.

All of samples showed significant increase in their hardness during the first week, and then their hardness increased gradually. The hardness of coated samples is 2-3 times greater than that of uncoated samples.

Table 1. Multivariate ANOVA analysis.

Parameters	Sum of squares	Degree of freedom	Mean squares	P-value
Material	391.248	1	391.248	0.802
Coating	25281.000	1	25281.000	0.000
Time	7480.940	4	1870.235	0.000
Material-Coating	316.128	1	316.128	0.000
Coating-Time	1099.900	4	274.975	0.000
Material-Time	56.474	4	14.118	0.000
Material-Coating-Time	143.394	4	35.848	0.000

Table 2. Tucky posthoc test analysis.

Kind of material and coating	Kind of material and coating	Mean differences	P-value
Uncoated Acropars	Coated Acropars	-28.2440	0.000
	Uncoated Viscogel	-0.4000	0.999
	Coated Viscogel	-35.7560	0.000
Coated Acropars	Uncoated Acropars	28.2440	0.000
	Uncoated Viscogel	27.8440	0.000
	Coated Viscogel	-7.5120	0.036
Uncoated Viscogel	Uncoated Acropars	0.4000	0.999
	Coated Acropars	-27.8440	0.000
	Coated Viscogel	-35.3560	0.000
Coated Viscogel	Uncoated Acropars	-35.7560	0.000
	Coated Acropars	7.5120	0.036
	Uncoated Viscogel	35.3560	0.000

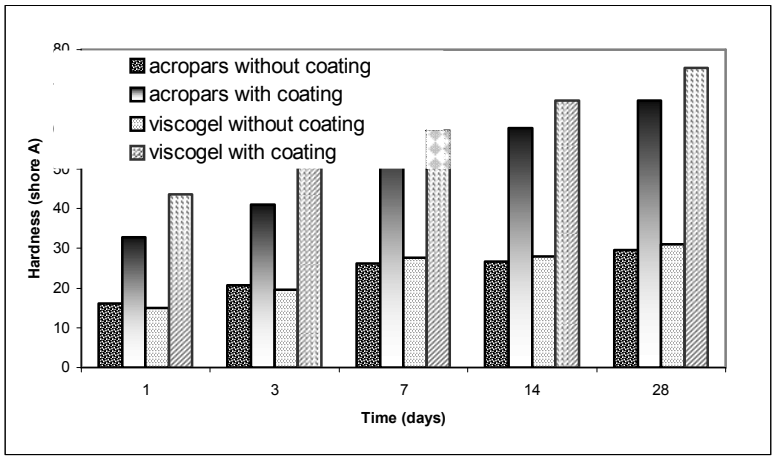

Figure 1. Increasing of hardness average during one month.

Discussion

The softness of tissue conditioners and its maintainance has a great importance.

Jones has found that ethanol is the main material that leaches out in first day, and its loss is the essential reason for increasing the hardness [11]. However, according to Graham's study, the loss of plasticizers is responsible for increasing the hardness for in vivo conditions. They have suggested that dibutyl phthalate (DBP) is washed out more than butyl phthalate buthyl glicolate (BPBG) [12].

In this research the results indicated that the hardness of all samples (with and without coating) increased with time. This may be attributed to the loss of ethanol and/or plasticizers. However, because the experimental condition was not in the mouth and there was not any saliva as a solvent, the main factor seems to be the loss of ethanol in soft liners.

The results also showed that the hardness of uncoated samples is the same for both Acropars and Viscogel at different times, and the kind of TC is not a significant factor. It may be related to loss of alcohol and probably plasticizers only. On the other hand, the coating of samples had significant effect on hardness progressing ($P<0.05$). The difference in this stage can be related to different composition of the materials and their responses to coating layer. Hence, the influence of Monopoly coating on maintaining the softness of Acropars is greater than of Viscogel.A significant difference is observed between the hardness of coated and uncoated samples of each group ($P<0.05$). The coated samples show a greater hardness.

Malmsrom has studied the effects of Monopoly and Permaseal coating on maintaining the softness of GC tissue conditioner in mouth condition and it was shown that the use of both coatings keep the TC soft for a longer time up to one mounth [6]. This conclusion is in conflict to our observations. The reason is most probably due to the different kind of tissue conditioners. The TC materials may have different behaviors in response to coating. GC, Viscogel, and Acropars tissue conditioners have different compositions, different particle sizes, and different percentages of alcohol and plasticizers. These factors may lead to different treatments and interactions with coating and affect the softness of surface. On the other hand, the experiment condition seems to be an important factor that has been different in our research and these investigators. It seems that the invitro and invivo conditions of studies have different effects on results. The loss of ethanol and plasticizers are not identical for in vivo and in vitro conditions.

Dominguez has investigated the effect of Monopoly coating on weight loss of Viscogel samples maintained in 37ºC water for 4 weeks. The samples have been weighed at different time intervals. Weight loss has been observed in all samples after 24 hours, due to leaching of ethanol out from uncoated samples and loss of monomer from coated ones. However, at longer times uncoated samples have shown an increase in weight due to water adsorption, while coated samples continued to loss the weight probably due to loss of more ethanol. It has been concluded that coating could not protect materials from ethanol loss, but could prevent it from water adsorption [7]. Although, present study did not measured the weight of samples, but the role of coating agent can be compared with the results of Dominguez study.

The results obtained for weight loss cannot be necessarily generalized to the loss of softness. However, the prevention of Monopoly from water adsorption may also be considered as a reason for hardness increasing.

The different responses of tissue conditioners to coating have been confirmed also by Gronet. He has suggested that the difference in adhesion of coatings to TCs, and variation in compositions of TC are responsible for this different behavior; although, his study was done on resiliency of tissue conditioners. The resiliency was determined by measuring the energy absorbed by the soft liners stressed to a specific yield point [10]. Therefore, it can be concluded that the Monopoly coating does not save the softness of Acropars and Viscogel samples in water, most probably due to inhibition of water adsorptions as well as loss of monomer and ethanol. More experiments are recommended to be done about the loss of plasticizers.

Whitin limitation of the present study,it may be concluded that:

1- The hardness of uncoated samples of both Viscogel and Acropars tissue conditioners are similar at any time.

2- The coated samples of Viscogel and Acropars have different hardnesses at any time. Coated Viscogel has a greater hardness.

3- Monopoly coating do not have any effect on softness of Viscogel and Acropars tissue conditioners (regarding to the limitations of current research).

4- Uncoated tissue conditioners have more softness, relative to corresponding coated samples.

5- As the ideal range of hardness for TC is 20-25 Shore-A (13), it is concluded that the application of Monopoly coating on Acropars and Viscogel tissue conditioners is not recommended to be used in the mouth.

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