

A Comparison of the Reproduction of Surface Detail of Three Tissues Conditioning Materials over Time

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ABSTRACT

Statement of Problem: Although the basic use of tissue conditioners is to treat inflamed mucosa, they are also employed as functional impression materials. No information was obtained on the reproduction of surface detail of these materials over time.

Purpose: The purpose of this study was to evaluate changes in the surface quality of three tissue conditioners after being immersed in water for a period of time.

Materials and Method: Detail reproduction was determined by using from a ruled test block the same it was specified in ISO Specification 4823. Three tissue conditioners (GC, Acrosoft, and Visco-gel) were evaluated. Samples were made by pouring freshly mixed materials into a ruled test block. The samples were then stored in distilled water for either of the followings periods of time: 0 hour, 24 hours, 3 days, 7 days, 14 days. Subsequently, the dental stone was mixed with distilled water and poured on each sample and allowed to remain for 60 minutes. Then, 25 specimens were prepared. The detail reproduction was determined based on what is specified in ISO Specification 4823. The samples were examined under a stereo-microscope with low-angle illumination. The data was analyzed through running Kruskal-Wallis Test and Mann-Whitney Test.

Results: The three materials had minimum standard of detail reproduction. The detail reproduction were more significantly influenced by the time period of immersion in water ($p < 0.0005$) than the type of the material. The best detail reproduction was pertained to Visco-gel not immersed in water. Acrosoft was less influenced by the time period of immersion in water than the two other types.

Conclusion: The detail reproduction may be attributed to chemical composition. The type of material and immersion time had a significant effect, while the effect of the type was less significant. The best time for making functional impressions was ranges from 0 to 24 hours.

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Introduction

Tissue conditioners are used for conditioning of denture-bearing inflamed mucosa by ill-fitting dentures prior to fabricating new dentures, for relining the existing dentures, and for provisional relining of immediate dentures and ill-fitting dentures [1-2]. Tissue conditioners have also been used as functional impression materials [1-3]. Their efficacy as functional impression materials is influenced by rheological properties [4-5], dimensional stability [6-7], ability to reproduce details

[6], undercuts and durability [4-5]. Clearly, two properties of impression materials; dimensional accuracy and detail reproduction, are prerequisites for successful impression [8].

Tissue conditioners, generally offered as powder and liquid, are mixed and used clinically in denture. The powder includes of polyethyl methacrylate or a related copolymer, whereas the liquid is an ester plasticizer, such as dibutylphthalate, butylphthalyl butyl glycolate, butyl benzyl phthalate or dibutylsebacate,

and 4- to 50 wt% ethyl alcohol [9-11]. The indeed, these materials show viscoelastic behavior suitable for tissue conditioning and functional impression making. However, it has been reported that tissue conditioners endured a significant loss of initial viscoelastic properties [4-5,12], dimensional changes [6-7], and diminution of detail reproduction [5, 12] over time to due the exiting plasticizer and ethyl alcohol components [13] as well as water absorption in this material [7, 14].

One study has reported the detail reproduction of irreversible hydrocolloid and elastomeric impressions [20].

In order to assess the physical properties of tissue conditioners, which are used as functional impression materials, it is also necessary to determine changes in the detail reproduction of the materials over time. The purpose of the present study was to evaluate changes in the surface conditions of three types of tissue conditioners, which had been stored in water over time. It was hypothesized that the surface quality of dental stone casts made from tissue conditioners would be influenced by the type of tissue conditioner. It was further assumed that the quality of the tissue conditioner would be reduced by exposure to a wet environment.

Materials and Method

Table 1 shows three types of tissue conditioners which have been used in the current study.

Reproduction of the surface details of the stone-

casts made from the tissue conditioners was determined according to the International Organization for Standardization (ISO) Specification 4823 for elastomeric impression materials and ADA Specification N. 19 (American Dental Association) [9, 17]. Surface detail reproduction was evaluated complying with ADA Specification N.19 for detail reproduction: continuous replication of at least 2 of the 3 horizontal lines [18]. The dental stone casts made from the tissue conditioners were prepared using a ruled test block. The ruled block included two vertical and three horizontal lines which were parallel; 20, 50, and 75 μm in width, and intersected by fiduciary lines on the die surface [19] (figures 1a, 1b).

Immediately after mixing the powder and liquid of the tissue conditioner at $23 \pm 2^\circ\text{C}$, according to the manufacturer's recommendation, each mixture was poured into a ring mold and the test block was pressed down onto the material and then removed two hours after mixing. Next five specimens of each material were stored in distilled water at 37°C for 0 hour, 24 hours, 3 days, 7 days, or 14 days after preparation. The dental stone and water were mixed with a water/powder ratio, recommended by the manufacturer, in a rubber bowl manually and then mechanically under vacuum for 15 seconds. Each dental stone mixture was then poured over the surface of each tissue conditioner specimen under gentle vibration and was stored in air at $23 \pm 2^\circ\text{C}$ for 60 minutes. Subsequently, the dental stone cast was removed from the tissue conditioner and evaluated. A total

Table 1 Tissue conditioners which were tested

Material	Batch no. powder-liquid	Manufacture	Composition of powder ¹⁰	Plasticizer	(wt%)
GC	0002032 002041	GC Corp.Japan	Poly(ethyl methacrylate)	BPB.G.DBP	14.8
Acro- soft	UT 83005 151281-151281	Marlic medical industries co Tehran Iran	PEMA(polyethyl methacrylate); PBMA(polybutyl methacrylate)	DBP(dibutylphthalate)	10.0
Visco-gel	0004000985- 0004000590	Dentsplay De Trey GmbH, Konstanz, Germany	PEMA(polyethyl methacrylate); PMMA(polymetyl methacrylate)	BPB.G(butylphthalyl butyl glycolate); DBP (dibutylphthalate)	4.9



Figure 1a Schematic model **b** Ruled test block with 3 parallel liners and ring mold **c** Specimens of stones

of 25 specimens were produced for each tissue conditioner /stone cast combination, which resulted in five specimens of each combination for each time period of water immersion and totally 75 specimens were produced (Figure 1c).

The dental stone casts were examined under a stereomicroscope (MGC-10 N9116734 Russia Crak) with low angle illumination at original magnification x 4 to 12 with digital camera (Panaonic Multicam 480 PV-GS31 comcorder. Japan) finest line reproduced over the full length of 25 mm between the intersection lines was recorded.

If the line was completely reformed, sharp, clear, and continued, it was identified by number 1. If the reformed line was continued but it had rounded and unclear angle, it was identified by number 2. If there was a clear destruction or uncontinuity in the reformed line, it was identified by number 3. If the line was not completely reformed, it was identified by number 4. Subsequently, samples were graded according to the detail registration and then studied statistically.

According to the ISO standard, the impression material should be able to reconstruct a slot with the width of 50 μ.

The final evaluation result was obtained through reproduction of the finest line by at least 2 casts.

Results

The results of Kruskal-Wallis Test indicated significant differences among the tissue conditioners ($p < 0.0005$) and significant effects of immersion time in water ($p < 0.0005$).

The best detail registration degree was related to the 75μm line with zero hour of immersion time and the worst registration degree was related to the 20μm line with 14 days of immersion time.

Table 2, 3 and 4 shows the detail reproduction of these three tissue conditioners. All the stone casts which were made from Visco-gel and not immersed in water reproduced the 20 μm line, while the other combina-

tions reproduced the 50 μm line. No stone casts made from Acrosoft or GC reproduced any line after 24 hours of immersion time.

Table 2 The Mean score line of reproduction of 20-μm for the three different tissue conditioners

		Time immersed (days)					
T.C	Score	0	1	3	7	14	P.value
Visco-gel		1.6	1.6	2.4	3	3.4	0.001
Acrosoft		2.2	2.8	3.2	3.4	3.8	0.005
GC		2.6	3	3.2	3.4	3.8	0.018

Table 3 The Mean score line of reproduction of 50-μm for the three different tissue conditioners

		Time immersed (days)					
T.C	Score	0	1	3	7	14	P.value
Visco-gel		1	1.4	2	2.4	2.8	0.001
Acrosoft		1.2	2	3	3	3	0.000
GC		1.8	2.4	2.8	2.6	3	0.016

Table 4 The Mean score line of reproduction of 75-μm for the three different tissue conditioners

		Time immersed (days)					
T.C	Score	0	1	3	7	14	P.value
Visco-gel		1	1	1.4	2	2.4	0.004
Acrosoft		1	2	2	2.4	2.2	0.001
GC		1.2	1.6	2	2.6	2.6	0.004

Table 5 shows the Minimum, the Maximum and the Mean scores of the lines of reproduction: 20μm; 50μm; and 75μm, of each type of the three tissue conditioners. Table 6 shows the P-values for the three types of tissue conditioners over time. The best pouring time was immediately after molding. Delay in pouring time decreased the degree of detail registration.

Based on the findings of Mann-Whitney Test, in registration of all the three lines from each of the three materials for different pouring times, there was a meaningful difference between times 0 hour and 14 days.

With regard to all the three materials in registration of all the three lines, the delay in pouring time

Table 5 The Minimum, Maximum and Mean scores of the lines of reproduction for the three types of tissue conditioners

T.C	Score	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Visco-gel		1	4	2.4	1	3	1.92	1	3	1.76
Acrosoft		2	4	3.8	1	3	2.44	1	3	1.92
GC		2	4	3.2	1	3	2.5	1	3	2

Table 6 P-values for the three types of tissue conditioners over time

Time of storage in water	20 μ	50 μ	75 μ
0	0.011	0.026	0.368
1	0.004	0.022	0.009
3	0.044	0.004	0.030
7	0.280	0.141	0.141
14	0.326	0.368	0.459

would result in a decrease in the details registration.

With regard to Visco-gel between the times 0 and 24 hours, the difference was not significant in each of the three lines registration, but it was significant in other cases.

There was not any significant difference among the three investigated materials in 0 time of pouring in the registration of the 75- μ m line, but the difference was meaningful in the registration of 20- μ m and 50- μ m lines. In 1-day and 3-days pouring times, too, there was a significant difference in the registration of all the three lines for all the three materials, and in 7-day and 14-day pouring times the difference was not significant.

According to the findings of this study, the best pouring time for all the three materials was immediately after molding and delay in pouring time would result in a decrease in details registration. All the three materials were in a standard level according to the details registration. Among the three materials, Visco-gel showed the best details registration in different pouring times, Acrosoft took the second place, and GC showed the worst. When there was a delay in pouring time, the details registration of Acrosoft, in comparison with the other two materials, tolerated less change.

Discussion

The results of this study have proved the detail reproduction of stone casts made from tissue conditioners is influenced by the type of tissue conditioner used. Furthermore, detail reproduction decreases over time.

The results of the present study indicated that detail reproduction of dental stone casts which were made from tissue conditioners was more greatly influenced by the immersion time of tissue conditioner in water than by the type of tissue conditioner. Although the type of tissue conditioner had some influence on the detail reproduction, too, its influence was less significant than the influence of the immersion time. The detail reproduction of the tissue conditioner decreased with an

increase in the immersion time in water because of the changes which occurred in the surfaces of the tissue conditioner over time. The deterioration in surface condition of the tissue conditioners with time was likely due to the leaching out of the low-molecular-weight plasticizer and, especially, ethyl alcohol from the materials along with water absorption [23].

Visco-gel showed a better detail reproduction during immersion time in water than the other two materials, probably because the liquid portion of this material consists of a considerably lower percentage of ethyl alcohol (4.9 wt%), a higher-molecular-weight ester, butyl phthalyl butyl glycolate (mol. wt, 336; 86.9 wt%) and dibutyl phthalate (mol. Wt, 278; 8.2 wt%). GC contains a lower-molecular-weight ester and has a lower powder/liquid ratio (0.90), and thus a larger amount of ethyl alcohol. Therefore, it showed a larger decrease in the detail reproduction over time. The surface detail reproduction of tissue conditioners may be attributed to chemical composition, molecular weight and particle size distribution of polymer powders, in addition to the composition of the liquids. Further research into the relationships among surface conditions and the composition and structure of these materials is necessary [20-21].

Tissue conditioners are used for tissue conditioning, functional impression making, and provisional relining. Furthermore, they are used in implant treatments. Their physical properties, such as viscoelasticity [7] and dimensional stability [6-7], which make them suitable for a variety of purposes, are different depending on different materials. That is, if the material is almost ideal for one purpose, it may not be ideal for another. Thus, a single type of tissue conditioner may not be capable to fulfill all the intended purposes equally well. It was found out that some of the examined tissue conditioners were not suitable for making a functional impression, because changes in the detail reproduction considerably varied over time. When a tissue conditioner is used to make a functional impression, it should flow and register the main shape of the denture-bearing mucosa under certain functional stresses such as mastication, speech, swallowing, and parafunctional habits. A functional impression should remain intraorally for at least 24 hours before pouring the dental stone cast in order to avoid distortion of the

impression surface caused by insufficient elastic recovery of the tissue conditioners [4]. The tissue conditioners must also have dimensional stability and high compatibility with the dental stone.

Visco-gel produced a better surface detail reproduction and exhibited minimal changes over time in the present study. Furthermore, in a previous study it was reported that Visco-gel behaved in a more stable manner dimensionally [7]. From the standpoint of detail reproduction, Visco-gel may be more suitable for making a functional impression than the other materials which are tested. In addition, it has been observed that Visco-gel has the lowest elastic recovery and the most compressibility in comparison to the other tissue conditioners [3]. Therefore, concerning surface quality, viscoelasticity, and dimensional stability, it seems that Visco-gel is a suitable material for making function impressions [2, 9, 22].

The recommended period of time for making a functional impression is 24 hours after the application of GC and Acro-soft or between 24 hours and 3 days after the application of Visco-gel. Clinically, the authors have observed that the surface of Visco-gel remains glossy after being remained in the mouth for a few days. The surface detail reproduction of tissue conditioners was influenced by many factors including the effects of saliva, denture cleansers, thermal cycling, and masticatory forces. Thus, changes in detail reproduction over time can be clinically different from those obtained in the present study. To make an accurate functional impression, a material which is used inside a denture must have sufficient bulk and a thickness of approximately 2mm [2]

Without being immersed in water, all of the examined tissue conditioners had the minimum detail reproduction (50- μ m line) on the dental stones specified in the ISO specification for elastomeric impression materials [21], though some combinations produced a better surface detail (20- μ m line). The lines lost their sharpness in varied degrees, depending on the period of immersion time of the tissue conditioners in water, and probably due to deterioration in the surface and, especially, flow properties of the materials. Application of a tissue conditioner under the present experimental conditions but with increased flow will lead to a large diminution of the reproduction of the lines over time.

Materials with increased flow may run more readily and will register the surface details in the mouth more effectively. It is worth mentioning that the present method did not necessarily simulate the clinical conditions. Considering the two previously mentioned phenomena, it is necessary to establish an experimental method for determining surface detail reproduction of dental stone casts made from tissue conditioners.

An ideal tissue conditioner which is used as a functional impression material should have high compatibility with the dental stones and a smooth surface equivalent to that of elastomeric impression materials. Furthermore, those properties should be maintained intraorally until a functional impression is formed. However, it appears that an ideal material does not currently exist. Therefore, there is a need for further research and development to provide materials which fulfill the previously mentioned requirements. There is a wide range of compatibility with dental stones and changes in the surface conditions among the available materials over time. Therefore, it is important to identify tissue conditioners that are suitable for making a functional impression and also to know application correct application time for each material.

Conclusion

Considering the limitations of this study, following results were achieved:

The type of the tissue conditioner and, especially, the time which is required for making functional impressions have a large influence on the detail reproduction of dental stone casts.

The surface detail reproduction of dental stone casts molded from tissue conditioners decreases significantly with increase in the immersion time. From the point of surface quality, the time period which is recommended for pouring functional impressions ranges from 0 hour to 24 hours after the application, depending on the type of the tissue conditioner which has been used.

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