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Research Araştırma

The Effect Of The Pre-Heating Process On Surface Roughness Of Compomer

Ön Isıtma İşleminin Kompomerin Yüzey Pürüzlülüğüne Etkisi

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ABSTRACT

Objective: In pediatric dentistry, where fast finishing processes are of great importance to reduce the roughness in order to obtain an ideal restoration surface. In restorative materials, differences in surface roughness may occur with the pre-heating process. Therefore, the aim of the study is to compare the surface roughness of the compomer prepared at four different temperatures.

Materials and Method: In this study, discs prepared from light-cured compomer prepared at four different temperatures were evaluated and their surface roughnesses were compared. Compomer, which was brought to pre-heat values using a composite heating device to bring it to 39 ºC and 55 ºC, was placed on silicone discs with a diameter of 10 mm and a thickness of 2 mm. The surface roughness was measured with a profilometer device. Statistical analysis was performed with One Way ANOVA and t-test.

Results: The surface roughness value of the compomer was the highest at 4 °C and the lowest at 55 °C. A statistically significant difference was found between the roughness value of compomer at 4 °C and the roughness values at 23 °C and 55 °C ($p<0.05$). The roughness values at 39 °C and 55 °C showed a statistically significant difference ($p<0.05$).

Conclusion: Differences can be observed in the surface roughness of the compomer with the pre-heating process. In order to obtain smooth surfaces, it is recommended to apply compomers in clinical usage by bringing them to the appropriate temperature.

Key Words: Compomer, Pre-Heat, Surface Roughness.

ÖZ

Amaç: Hızlı bitirme ve polisaj işlemlerine ihtiyaç duyulan çocuk diş hekimliğinde, ideal bir restorasyon yüzeyi elde edebilmek için pürüzlülüğü azaltmak büyük önem arz etmektedir. Restoratif materyallerde ön ısıtma işlemi ile yüzey pürüzlülüğünde farklılıklar oluşabilmektedir. Bu nedenle; çalışmanın amacı, dört farklı sıcaklıkta hazırlanan kompomerin yüzey pürüzlülüğünün karşılaştırılmalı olarak değerlendirilmesidir.

Gereç ve Yöntemler: Bu çalışmada dört farklı sıcaklıkta hazırlanmış olan ışıkla sertleşen kompomerden hazırlanan diskler değerlendirilerek yüzey pürüzlülükleri karşılaştırıldı. Buzdolabında bekletilerek, oda ısısında bekletilerek ve 39 ºC ve 55 ºC sıcaklığa getirmek için ise kompozit ısıtma cihazı kullanılarak ön ısı değerlerine ulaştırılan kompomer, 10 mm çapında ve 2 mm kalınlığında silikon disklere yerleştirildi. Polisajı tamamlandıktan sonra yüzey pürüzlülüğü profilometre cihazı ile ölçüldü. Elde edilen verilerin istatistiksel analizi One Way ANOVA ve t testi ile gerçekleştirildi.

Bulgular: 4 °C sıcaklıkta kompomerin yüzey pürüzlülük değeri en fazla, 55 °C sıcaklıkta ise en düşük bulundu. Kompomerin 4 °C'de gösterdiği pürüzlülük değeri ile 23 °C ve 55 °C'deki pürüzlülük değerleri arasında istatistiksel olarak anlamlı fark bulundu. ($p<0,05$) 39 °C ve 55 °C'deki pürüzlülük değerleri istatistiksel olarak anlamlı fark gösterdi ($p<0,05$).

Sonuç: Ön ısıtma işlemi ile kompomerin yüzey pürüzlülüğünde farklılıklar gözlenebilmektedir. Pürüzsüz yüzeyler elde edilebilmesi amacıyla klinik kullanımda kompomerlerin uygun ısıya getirilerek uygulanması önerilebilinir.

Anahtar Kelimeler: Kompomer, Ön Isıtma, Yüzey Pürüzlülüğü.

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INTRODUCTION

Dental caries, which can vary in severity and intensity, and is frequently encountered in childhood, primary, and permanent dentition, is defined as a chronic disease all over the world (1,2). There are many restorative materials with different physical properties and chemical structures that are used in pediatric dentistry from the past to the present in order to prevent caries formation and stop and treat caries (1,3,4). Although the restorative material with all the desired properties is still not found, compomers called polyacid-modified composite resin (PMCR) are frequently preferred in pediatric dentistry (1,5). Compomers are hybrid materials that have the composition of glass ionomer cement, but are introduced to the market with the further improvement of the properties of these cement, and also have similar properties to composite resins (1,6). It stands out as the most used material in aesthetic restorations of primary teeth because its manipulation is suitable for limited and short working conditions in children without the need for acid application, shows anti-cariogenic properties, its corrosion level is close to the rate of loss of primary teeth (1,6-9).

In addition to iatrogenic factors such as cavity design and application technique, the characteristics of the material such as color match, brightness, bacterial impermeability, and polymerization shrinkage also play an important role in qualifying an aesthetic primary tooth restoration as successful and long-lasting (4,10,11). At the same time, the simple finishing and polishing processes that an ideal restoration should have, and accordingly the surface roughness, are the most important factors affecting the long-term success of the restoration (4,12,13). While finishing is the shaping of the margins by abrasion so that the restoration has the ideal anatomical form, polishing is the removal of small irregularities that occur after the finishing process (13). Restorations that are poorly polished, rough, and do not have a smooth surface, increase food accumulation and plaque retention due to the decrease in chewing functions, and accordingly, caries formation under the restoration is more common in the long term. While soft tissue damage is observed in restorations with inappropriate contacts, the risk of fracture increases due to the increase in corrosion of the restoration. Additionally, aesthetic properties are adversely affected due to discoloration and corrosion (4,8,12-14).

There are many factors affecting surface roughness (14). Examples of these are the type of restorative material preferred, the amount and size of filler it contains, single or double-stage polishing systems, the hardness of the abrasive used, and the difference in hardness between the abrasive and restorative material (13,14). Studies on the effect of heat, which is known to have a positive effect on the mechanical properties of materials, on surface roughness are limited (15). The aim of this study is to comparatively evaluate the surface roughness of compomer restorations polished at four different temperatures (4 °C, 23 °C, 39 °C, 55 °C).

MATERIAL AND METHODS

In this *in vitro* study, discs preheated at four different temperatures (4 °C, 23 °C, 39 °C, 55 °C), light-cured, and prepared using compomer (Glasiosite caps. A2, Voco, Germany) were evaluated and their surface roughnesses were compared. The compomer used is in capsule form weighing 0.25 grams and contains BIS-GMA, urethane-methacrylate, TEGDMA, and Butyl Hydroxy Toluene (BHT). The study samples were divided into 4 different groups according to the temperature values of the compomers, and each group was carried out by preparing a total of 48 samples, including 12 samples.

In order to bring the compomer to 4 °C, the capsules were kept in a refrigerator at 4 °C for 48 hours, while in order to reach room temperature, the capsules were kept at 23 °C for 48 hours. In order to bring the compomer to 39 °C and 55 °C, the composite heating device with two different temperature options, T1 (39 °C = 102.2 °F) and T2 (55 °C = 131 °F), was used in accordance with the instructions determined by the manufacturer (Micerium, S.p.a., Avegno GE, Italy). Compomers, which reached the desired temperature, were applied to overflow with a compomer gun to cylindrical standard discs prepared from non-stick silicone with a diameter of 10 mm and a thickness of 2 mm. Firstly, a transparent tape was placed on both surfaces of the material, then the overflow material was removed by applying pressure with the help of a cement glass (100 mm x 100 mm x 4 mm). Both surfaces of the material were cured by polymerization for 20 seconds with a portable LED light device (Elipar S10, 3M ESPE, St. Paul, USA). The samples were kept in distilled water for 24 hours to complete the polymerization.

All samples were polished by the same investigator using the Optidisk (KERR, Switzerland) polishing system. Coarse (Brown - 80 µm), medium (Light brown - 40 µm), fine (Orange - 20 µm), and superfine (Yellow - 10 µm) aluminum oxide discs were used, respectively. After the completed polishing process, the surface roughness of the samples was measured with a profilometer device (Perthometer M2, Mahr, Göttingen, Germany). The average surface roughness value (Ra) was calculated by making three different measurements at the same distance and pressure. The recorded values were used in the comparison between groups. One-way analysis of variance and t-test were used in the analysis of the data. The significance level of the analysis was taken as p<0.05.

RESULTS

The values related to the surface roughness of the compomer used in our study at different temperatures are shown in Table 1.

According to the data obtained in the study, the surface roughness value of the compomer was found to be the highest at 4 °C and the lowest at 55 °C. A statistically significant difference was found between the roughness value of compomer at 4 °C and the roughness values at 23 °C and 55 °C (p<0.05). Compared with 4 °C and 39 °C, although the roughness decreased with increasing temperature, no statistically significant difference was found. (p>0.05) There was a statistically significant difference between the roughness values between 39 °C and 55 °C, which decreased with increasing temperature (p<0.05).

	4 °C	23 °C	39 °C	55 °C
Surface roughness (Ra) n=12	2683.17±844.6[a]	1419±537.6[b,c]	2091±703.6[a,c,d]	1312.92±545.6[b,c,e]

Table 1. ΔE measurements by materials.

DISCUSSION

Roughness, which is one of the mechanical surface properties of restorative dental materials, is defined as small surface irregularities that negatively affect the clinical success and performance of restorations in the long term, reduce their stability, increase their susceptibility to aging, and cause aesthetic problems (14,16,17). When we take a look at the literature, it is seen that in the studies conducted to evaluate the surface roughness, in addition to prosthetic materials such as non-precious metal alloys and dental ceramics, restorative materials with different mechanical and chemical properties such as conventional glass ionomer cement, resin-modified glass ionomer cement (RMGIC), composite resins and compomers were also evaluated (8,17,18,). Although there are many factors affecting the roughness, the precision of the studies evaluating the roughness of the preheating process, which is known to improve the mechanical and physical properties of restorative materials after its application to composite resins, is controversial and the number of data is limited (13-15). There are no studies on the effect of pre-heating on the surface roughness of compomer restorations, which are frequently used with the increase in aesthetic expectations in pediatric dentistry.

Studies evaluating restorative materials can be performed in vivo and in vitro (19). In this study, silicone discs were preferred due to standardization, ease of preparation, and elasticity, taking into account the previous studies (19,20). In order to prevent incomplete polymerization of resin-containing materials, these discs were prepared with a thickness of 2 mm, as in the studies of Yap et al. (21) and Mohamed-Tahir et al. (22). Transparent tapes were used to provide the smoothest surface after polymerization, to eliminate the oxygen inhibition area and with the recommendation of the manufacturer, but transparent tapes cannot always be used before polymerization and clinical polishing processes are required (13). Patel et al. (23) reported that using only transparent tape would not be sufficient, and polishing applications were required. Although there are many different methods used, the aluminum oxide disc system was used in our study with reference to the work of Bouvier et al. (24), which showed that the smoothest surface in compomer restorations is provided with aluminum oxide discs. Cement glass, on the other hand, enabled the light device to be applied from a certain distance (25-27). In line with all these parameters, the present study was carried out in vitro.

Preheating of resin-containing restorative materials became a widely used technique in recent years, but studies on heating compomers are not found in the literature. While studies on the heating of glass ionomer cement, which are one of the materials that make up the basic composition of compomers, are limited, it is seen that properties such as surface hardness, marginal adaptation, color change, viscosity, durability were evaluated in studies where composite resins, which are the other material in its composition, were subjected to heat (28). When the studies evaluating the surface roughness with heat exchange are examined, Elkaffass et al. (15), in their study, evaluated the surface roughness of composite resins first at 24 °C room temperature and then at 68 °C after preheating. Although there was an increase in the mean roughness value after preheating, no significant difference was found and they reported that preheating did not affect the surface roughness of the composites.

Similarly, in our study, when the surface roughness of the compomer material at 23 °C room temperature and the roughness value at 39 °C were compared, the roughness value increased as a result of heat treatment, but no significant difference was found. Pala et al. (29) in their study examining the effects of preheating and the usage of different polishing systems on the hardness and surface roughness of composites, stated that heat application had no effect on surface roughness. In a study conducted by Oskooe et al. (30), siloxane-based composite resin syringes were kept in a water bath adjusted to 55-60 °C for 15 minutes and their surface roughness was evaluated. A significant increase in surface roughness was observed compared to the non-preheated group. It is thought that the covalent bonds between the resin matrix and the particles weaken as a result of thermal cycling and increase surface roughness. In the present study, on the contrary, the compomer material showed the lowest roughness value at 55 °C as a result of preheating. This result is due to the fact that the material used in the present study is a compomer containing not only composite resin but also glass ionomer. Compomers contain fluoroalumino silicate and acidic polymers, which are glass ionomer cement compositions, in addition to composite resins (31) and it is known that the structure of restorative materials affects roughness (13,14). In a study, heat was applied to glass ionomer cement samples, and the surface roughness was measured less than the non-heat applied group (32). Contrary to the surface roughness that increases as a result of pre-heating of composite resins, it is thought that pre-heat application positively affects the surface roughness of glass ionomer cement in compomer structure and accordingly smoother surfaces are obtained.

Before the polymerization process, the thermal vibrations that occur as a result of the preheating process applied to the resin-containing restorative materials increase the movement of the molecules and accordingly the fluidity of the materials (33). There are also studies arguing that there may be changes in the surface roughness values with the increase in the fluidity of the materials (34). In a study, pre-heat was applied to the composites and as a result of the decrease in viscosity, fluidity was achieved that could inject the material into the cavity instead of using traditional hand tools. Although there was no significant difference in the roughness value, an advantage was obtained by approaching the surface properties to the flowable composite (15). In a study conducted by Lee et al. (35), it was reported that the viscosity of resin-containing materials decreased, facilitating the transport and application of the material into the cavity. In the present study, the surface roughness decreases due to the ease of manipulation with the increase in the fluidity of the compomer subjected to the pre-heating process.

CONCLUSION

In conclusion, it is thought that there may be differences in the surface roughness values of the pre-heated compomer. Especially in pediatric dentistry, where faster finishing and polishing are required, it is important to reduce the roughness in order to obtain an ideal restoration surface. For this reason, in order to obtain smooth surfaces in restorative applications in pediatric dentistry, it is recommended to apply compomers by bringing them to the appropriate temperature.

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