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Efficacy of Different Finishing and Polishing Systems on Surface Roughness and Microhardness of Highly Aesthetic Composites

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ABSTRACT

Objectives: The aim of this study is to examine the effect of three different types of highly esthetic composite resins, which will be used for aesthetic purposes in the anterior region, on the surface roughness and microhardness by the application of three different finishing and polishing systems, with three-dimensional Optical Profilometer, Vickers microhardness device and SEM analysis.

Materials and methods: Three different composite resins were used in the study; supra-nanophile (Tokuyama Estelite Asteria), supra-nano spherical (Tokuyama Omnichroma), nanohybrid (Kuraray Clearfil Majesty Esthetic) were used. 40 samples of each composite resin were prepared, 120 in total. After the polymerization and correction processes, ten samples from each group that did not undergo any polishing process were separated as the control group. Then, they were randomly divided into three groups for the polishing process: 4-stage aluminum oxide coated disc (3M Sof-lex disc), beige and pink 2-step spiral rubber consisting of aluminum oxide-containing diamond particles (3M Sof-lex spiral), polyurethane, diamond granules. containing light blue rubber and spiral rubber (Ivoclar Vivadent OptraGloss). Surface roughness (Ra) was measured on all samples with a conventional profilometer device. Then, one sample surface from each group was examined with the Optical Profilometer device and the Scanning Electron Microscope, and all samples were subjected to microhardness testing with the Vickers Microhardness Tester.

Results: As a result of our study, the lowest roughness values were observed in the control group, while the highest roughness values were observed in the Ivoclar Optragloss group. The groups studied with Kuraray Clearfil Majesty Esthetic composite showed higher roughness values compared to other composite groups, but no statistically significant difference was found with other composite groups ($p>0.05$). In our study, the lowest microhardness values were observed in the control group, while the highest microhardness values were observed in the Sof-Lex Disk group. The difference between the groups treated with Kuraray Clearfil Majesty Esthetic composite and the other composite groups was found to be statistically significant ($p<0.05$). The lowest microhardness values were observed in the groups treated with Kuraray Clearfil Majesty Esthetic composite.

Conclusions: It was observed that the effectiveness of the polishing systems used on different restorative materials was different, and when the polishing systems were compared, the Soflex multi-stage disc system and the Soflex two-stage spiral tire system were found to be more successful.

Keywords: Aesthetic Composite, Surface Roughness, Microhardness.

Farklı Bitirme ve Polisaj Sistemlerinin Yüksek Estetiğe Sahip Kompozitlerin Yüzey Pürüzlülüğü ve Mikrosertliği Üzerine Etkinliği

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ÖZ

Amaç: Çalışmamızda amaç; anterior bölgede estetik amaçla kullanılacak üç farklı tipteki yüksek estetiğe sahip kompozit rezine, üç farklı bitirme ve polisaj sistemlerinin uygulanmasıyla, yüzey pürüzlülüğüne ve mikrosertliğine etkisini üç boyutlu Optik Profilometre, Vickers mikrosertlik cihazı ve SEM analizleri ile incelemektir.

Gereç ve Yöntemler: Çalışmada 3 farklı kompozit rezin; supra-nanofil (Tokuyama Estelite Asteria), supra-nano sferikal (Tokuyama Omnichroma), nanohibrit (Kuraray Clearfil Majesty Esthetic) kullanıldı. Toplam 120 adet olmak üzere her bir kompozit rezinden 40'ar adet örnek hazırlandı. Polimerizasyon ve düzeltme işlemlerinden sonra, her gruptan herhangi bir polisaj işlemi uygulanmamış on örnek, kontrol grubu olarak ayrıldı. Daha sonra polisaj işlemi için rastgele üç gruba ayrıldı: 4 aşamalı alüminyum oksit kaplı disk (3M Sof-lex disk), alüminyum oksit içerikli elmas parçacıklardan oluşan bej ve pembe renkli 2 adımlı spiral lastik (3M Sof-lex spiral), poliüretan, elmas granüller içeren açık mavi lastik ve spiral lastik (İvoclar Vivadent OptraGloss).Yüzey pürüzlülüğü (Ra) konvansiyonel profilometre cihazı ile tüm numuneler üzerinde ölçüm yapıldı. Daha sonra Optik Profilometre cihazıyla ve Taramalı Elektron Mikroskobuyla tüm gruplardan birer adet örnek yüzeyi incelendi ve tüm örnekler Vickers Mikrosertlik Test Cihazıyla mikrosertlik testine tabi tutuldu.

Bulgular: Çalışmamızın sonucunda en düşük pürüzlülük değerleri kontrol grubunda gözlenirken, en yüksek pürüzlülük değerleri ise İvoclar Optragloss grubunda gözlenmiştir. Kuraray Clearfil Majesty Esthetic kompozit ile çalışılan gruplar, diğer kompozit gruplarına göre yüksek pürüzlülük değerleri göstermiş ancak diğer kompozit gruplarıyla istatistiksel olarak anlamlı bir fark bulunamamıştır ($p>0,05$). Çalışmamızda en düşük mikrosertlik değerleri ise kontrol grubunda gözlenirken, en yüksek mikrosertlik değerleri ise Sof-Lex Disk grubunda gözlenmiştir. En düşük mikrosertlik değerleri Kuraray Clearfil Majesty Esthetic kompozitle çalışılan gruplarda gözlenmiştir.

Sonuçlar: Kullanılan polisaj sistemlerinin, farklı içerikli restoratif matertaller üzerinde etkinliğinin farklı olduğu, Sof-Lex çok aşamalı disk ile Sof-Lex iki aşamalı spiral lastik sistemlerinin, İvoclar Optragloss sistemine göre daha başarılı olduğu söylenebilir.

Anahtar Kelimeler: Estetik Kompozit, Yüzey Pürüzlülüğü, Mikrosertlik.

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Introduction

Dentists and patients attach great importance to both the function and aesthetic appearance of teeth. With the increasing interest of patients in aesthetics, the use of resin-based composites is increasing with the developments in bonding procedures and materials.[1]

Over time, with the increasing interest in aesthetics, composite resins have been widely used in the anterior and posterior regions.[2,3]

In composite resins, nanocomposites started to be produced with the development of nanotechnology. The term 'nanotechnology' was developed to describe smaller dimensions that cannot be scaled with micro-technology.[4] When the inorganic phases in the composite content become nano-sized, they are called nanocomposites. Due to the fact that nanocomposites contain very small inorganic filler particles, more successful polishing process and ultimately smoother surfaces can be obtained.[5]

In obtaining composite resins with smooth surfaces, the type and content of the material is important as well as the finishing and polishing systems. There are studies indicating that when appropriate finishing and polishing processes are performed, plaque retention will be reduced, discolouration and recurrent caries can be prevented in this way.[6]

The finishing process provides shaping of the restoration by removing the excesses on the restoration surface and the polishing process provides an aesthetic appearance and shine to the restoration and eliminates the retention areas that cause discolouration.[7]

The presence of rough areas in composite restorations may cause deterioration of the aesthetic appearance, plaque retention and therefore surface discolouration and secondary caries formation.[7]

Many different methods can be used to measure surface roughness. The main ones are mechanical and optical profilometers, transmission electron microscopy (TEM), atomic force microscopy (AFM) and scanning electron microscopy (SEM).[8]

Quantitative methods such as contact profilometer and optical profilometer and qualitative methods such as SEM can be used in surface roughness measurement.[9] Both quantitative and qualitative measurements of the surface can be performed successfully with optical profilometer, also called laser profilometer. Optical profilometers have higher measurement accuracy, can give more detailed and faster results than mechanical profilometers, and can also provide 3D images of the measured surfaces.[10]

Another important property of composite resins is microhardness. This structural property plays an important role in terms of the mechanical life of the restoration.[11] The microhardness of composite resins can be defined as the resistance of the composite against the pressures created by rigid materials.[12]

The aim of this study was to investigate the effect of three different finishing and polishing systems on the surface roughness and microhardness of three different types of highly aesthetic composites to be used for aesthetic purposes in the anterior region with three-dimensional Optical Profilometer and SEM analyses.

Material and Methods

Preparation of Composite Samples

Ethics Committee approval dated 10.02.2021 and numbered 2021-02/42 was obtained by Sivas Cumhuriyet University Non-Interventional Clinical Research Ethics Committee to start the study. A total of 120 composite resin samples were prepared using cylindrical metal molds made of stainless steel with a diameter of 8 mm and a thickness of 2 mm. After the composite resins were placed in metal molds, they were compressed with a transparent tape on the upper and lower surfaces. Then samples were obtained by polymerized using a 10 s with LED light device (VALO Cordless, Ultradent, USA). Then, 600, 800 and 1000 grit silicon carbide papers were applied to the surfaces, respectively, to obtain a standard smear layer.

Experimental Groups

The composite resins used were divided into 3 main groups according to their content. For each main group, 40 samples were used. This study, the composites tested and their composition information are given in Table 1.

***Asteria Composite Group*:** Tokuyama Asteria composite (Tokuyama Dental Tokyo, JAPAN) specimens were prepared using cylindrical metal molds and subjected to processes as described above (n=40).

***Omnichroma Composite* Group:** Tokuyama Omnichroma Single-shade composite (Tokuyama Dental Tokyo, JAPAN) specimens were prepared using cylindrical metal molds and subjected to processes as described above (n=40).

***Kuraray Clearfil Majesty Esthetic Composite Group*:** Kuraray Clearfil Majesty Esthetic Composite (Kuraray Noritake Dental, Okayama, JAPAN) specimens were prepared using cylindrical metal molds and subjected to processes as described above (n=40).

Each composite group was divided into 4 subgroups, as 3 experimental groups and 1 control group, according to the polishing systems to be tested (n=10). The material properties and manufacturers of the polishing systems used in the study are given in Table 2.

Sub-group 1: Control group:

No polishing system was applied to the samples in this group.

Sub-group 2: 3M Sof-lex Polishing Discs:

2nd Group is the Soflex disc system (3M ESPE, St Paul, Mn, USA), which is a multi-stage polishing system, using coarse, medium, fine and super fine grained aluminum oxide coated discs, respectively (15-20 seconds) with water cooling. It was used at a speed of 15.000 rpm under.

Sub-group 3: 3M Sof-lex Diamond Spiral Tire:

With 2-stage Sof-lex spiral rubber system (3M ESPE, St Paul, Mn, USA), beige colored spiral rubber for pre-polishing and pink colored spiral tire with diamond structure for high gloss, 15-20 seconds under water cooling at 15.000 rpm applied throughout.

Sub-group 4: Ivoclar Optragloss Polishing Systems:

Ivoclar Optragloss (Schaan, Leichtenstein), a polishing system consisting of rubber and spiral rubber was used, and light blue lens and flame-shaped tires and spiral rubber were used. The polishing process was carried out under water cooling at a speed of 15.000 rpm for 15-20 seconds.

Measurement of Surface Roughness

The surface roughness of the samples was measured using a profilometer device (Mitutoyo Surftest/ SJ-301, Tokyo, Japan). The average surface roughness value was calculated by taking the arithmetic average of the obtained data by measuring from three different regions of each sample.

Examination of Samples with Optical Profilometer Device

Using an optical profilometer device (Phase View, Zee Scope Compact 3D Digital Microscope, Verrieres Le Buisson, France), one sample from each group was randomly selected and a 3D non-contact image of a total of twelve samples were obtained.

Measuring Vickers Microhardness Values of Samples

The microhardness of each prepared restorative material was evaluated using the vickers microhardness tester (Shimadzu hmv-2/ hmv-2t vickers, Kyoto, Japan).

Analysis of the Surfaces of the Samples by Scanning Electron Microscopy

SEM analyzes of a randomly selected sample from each group were performed using the SEM device (Tescan MIRA 3, Czech Republic).

Statistical Analysis

The data obtained from this study were evaluated with SPSS (Statistical Package for the Social Sciences) 22.0 program one-way ANOVA and Tukey tests.

Results

Surface Roughness Results:

The average roughness values and standard deviation values obtained as a result of statistical evaluations of surface roughness tests are shown in Table 3.

As a result of the statistical evaluations, among the polishing materials; the lowest average roughness values were observed in the control group, while the highest average roughness values were observed in the Ivoclar Optragloss group. There was no statistically significant difference between the groups worked with Sof-lex disc and the groups worked with Sof-Lex Spiral in terms of roughness values ($p>0.05$). Sof-lex disc gave rougher surfaces in Tokuyama Omnichroma composite resin and Sof-Lex spiral gave rougher surfaces in Kuraray Clearfil Majesty Esthetic composite resin. When the composite groups were evaluated, the groups worked with Kuraray Clearfil Majesty Esthetic composite showed the highest roughness values in all groups except Ivoclar Optragloss group. The groups worked with Tokuyama Omnichroma composite resin gave the lowest surface roughness values compared to other composite resin groups.

When the Optical Profilometer Images were evaluated, it was seen that there are superficial fluctuations in the Tokuyama Estelite Asteria composite Control group (Figure 1.a), and the surface roughness in the sof-lex disc group (Figure 1.b) is less than the other groups.

When Optical Profilometer Images of Tokuyama Omnichroma composite are evaluated; While the distance between elevation and depth increases in the control group (Figure 2.a), it is seen that the roughness on the surface is less compared to the other groups, elevations and depths are seen in other polishing groups, but the frequency of roughness increases in the Ivoclar Optragloss group (Figure 2d.).

When the Optical Profilometer Images of the Kuraray Clearfil Majesty Esthetic Composite are evaluated, the elevations and depths are seen in the Control group (Figure 3.a). However, the distance between elevation and depth is less than Soflex disc and Ivoclar Optragloss groups. It is seen that the frequency of elevations and depths in the Ivoclar Optragloss group (Figure 3.d) is higher than the other groups.

Microhardness Values:

The mean microhardness and standard deviation values we obtained in Vickers microhardness tests and statistical evaluations between groups are shown in Table 4.

The difference between Tokuyama Estelite Asteria and Tokuyama Omnichroma composite groups (except the control group) is statistically significant ($p<0.05$). When working with Sof-lex disc and Sof-lex spiral polishing systems, Tokuyama Estelite Asteria composite gave higher microhardness values. When worked with Ivoclar Optragloss polishing system, Tokuyama Omnichroma composite gave higher microhardness values. The difference between the groups worked with Kuraray Clearfil Majesty Esthetic composite and other composite groups was found statistically significant ($p<0.05$). The lowest microhardness values were observed in the groups treated with Kuraray Clearfil Majesty Esthetic composite. In all composite groups, the difference between control and Sof-Lex disc polishing groups was statistically significant ($p<0.05$). The highest microhardness values were observed in the Sof-Lex Disc group and the lowest microhardness values were observed in the control group.

When the SEM analysis images are examined, it is seen that the smoothest surface in all composite groups is in the control group (Figures 4, 5, 6a). The SEM images of the Tokuyama Asteria composite groups polished with Sof-lex disk and Soflex spiral were very similar to each other. In the SEM analysis of the composite groups polished with Ivoclar optragloss, inorganic fillers were separated from the surface and many tiny pits and irregular block clusters were found on the surface (Figure 4.d).

In the SEM analysis of Tokuyama Omnichroma composite groups polished with Ivoclar optragloss, it was determined that a large number of inorganic fillers had broken off from the surface, many pits and a heterogeneous surface were seen on the surface (Figure 5.d). The composite polished with sof-lex disc and sof-lex spiral. Although the

SEM images of the groups were very similar to each other, the surface of the samples polished with the Sof-Lex spiral (Figure 5.c) was observed to be more homogeneous and smooth.

In the SEM analysis of the Kuraray Majesty Esthetic composite groups polished with Ivoclar optragloss, it is seen that the surface is very rough, the inorganic fillers are clustered in places or are broken off from the surface in the form of cracks in places (Figure 6.d). SEM images of the composite groups polished with Sof-Lex disc (When Figure 6.b) was examined, it was seen that the inorganic fillers followed a homogeneous distribution on the surface, and in the composite groups polished with the Sof-Lex spiral (Figure 6.c), although the surface was seen to be smoother, tiny cracks were found homogeneously on the entire surface.

Discussion

The aesthetics of composite restorations are affected by properties such as colour stability, surface roughness and gloss.[13-15] In addition, with the use of composite restorations in the posterior region, their mechanical properties have gained importance for the long-term success of restorations.[16] The microhardness values, which show the structural durability of the materials, affect the mechanical properties of the materials. It is known that as the microhardness of the material increases, wear resistance and mechanical durability increase.[17,18]

In this study, considering the developments in composite resin technology, the effect of supra-nanophile (Tokuyama Estelite Asteria), supra-nano spherical (Tokuyama Omnichroma), nanohybrid (Kuraray Clearfil Majesty Esthetic) anterior composite resins with high aesthetics on roughness and microhardness as a result of the application of different polishing systems were investigated by three-dimensional optical profilometer, Vickers microhardness tester and SEM analyses.

Finishing and polishing processes ensure that the residues that may be seen as a result of the restoration are removed and the desired surface smoothness is obtained in the restoration. Thus, by reducing plaque formation on the surface, it also prevents surface discolouration, gingival inflammation and secondary caries formation.[19-21]

Determining the finishing and polishing technique to obtain an ideal aesthetic appearance and a smooth surface in composite resin restorations is of great clinical importance.[22] In our study, we investigated the effects on surface roughness and microhardness of aluminium oxide coated multi-stage disc system (Sof-Lex disc), two-stage spiral rubber system (Sof-Lex Spiral) consisting of aluminium oxide and thermoplastic elostomer containing beige and pink coloured spiral rubber containing diamond particles, and single-stage polyurethane, light blue rubber containing diamond granules and spiral rubber (Ivoclar Optragloss) polishing systems.

Quantitative methods such as contact profilometer and optical profilometer and qualitative methods such as SEM can be used in surface roughness measurement.[9] Both quantitative and qualitative measurements of the surface can be performed successfully with the optical profilometer, also called laser profilometer. Optical profilometers have higher measurement accuracy, can give more detailed and faster results than mechanical profilometers, and can also provide 3D images of the measured surfaces.[10] Yamanel[23] used optical profilometer device in his study in which the effect of different prophylactic polishing processes on the surface roughness of microhybrid and nanohybrid composite resins were investigated. The reason for this is that optical profilometer devices have advantages such as fast measurement, not damaging the sample surface during measurement, micrometer and nanometer size measurements, and the ability to take two and three dimensional surface images. Davud *et al.*[24] also studied the effects of tooth brushing on the surface properties of micro-hybrid and nano-filled resin composites after different finishing and polishing processes using optical profilometer and SEM devices.

In our study, all samples were measured with a two-dimensional (mechanical) profilometer. In addition, one sample randomly selected from each group was analysed with a three-dimensional optical profilometer and SEM analysis was performed on one sample from each group to examine the composite resin surfaces.

Although composite resins have many physical and mechanical properties, one of the most important of these is microhardness.[25] It has been reported that finishing processes should be used in order to increase the surface hardness value of composite resin and in this way, a mechanically robust surface that is more resistant to abrasion will be formed.[26,27] Erdemir et al[28] applied different polishing systems (Sof-Lex disc, Pogo polishing system) on composite resins and compared their microhardness values. In their study, they argued that polishing systems increased the microhardness values, but they concluded that there was no statistically significant difference between polishing systems ($p>0.05$). Venturini *et al.*[29] reported that different polishing systems resulted in different microhardness values. In our study, multi-stage polishing with Sof-Lex disc resulted in the highest microhardness values. In Tokuyama Estelite Asteria composite group, Sof-Lex spiral polishing system gave statistically significantly higher microhardness values than Ivoclar Optragloss system ($p<0.05$). The results of our study are consistent with the results of Venturini *et al.* in terms of different polishing systems giving different results in terms of microhardness values.

Many studies have shown that the smoothest surfaces can be obtained with multi-stage aluminium oxide coated discs.[30-32] Bilgili et al [32] found that the smoothest composite surfaces were obtained with the sof-lex disc system. They argued that the reason for this is that since the composite surface is sanded gradually up to the fine particle discs, the polishing process is provided with the super fine disc, which is the last stage. Korkmaz et al [33], in their study; applied three different polishing systems (Pogo, Sof-lex disc, Optrapol) on six different composite materials, two nanofillers (Filtek Supreme XT, Aelite Aesthetic Enamel), two nanohybrids (Tetric EvoCeram, Grandio), one nanoceramic (CeramX) and one microhybrid (Filtek Z250) and examined the roughness values with surface profilometer and surface hardness with Vickers microhardness device. They reported that in the nanohybrid composite (Tetric EvoCeram) group, Sof-Lex polishing system showed higher roughness values than other polishing systems and in the microhybrid composite (Filtek Z250) group, PoGo polishing system showed higher roughness values. At the same time, the nanohybrid composite (Grandio), which had the highest filler content (87 wt%) in this study, showed higher microhardness values than the other composites. When all polishing systems were used, they stated that the lowest microhardness values were obtained in all of the groups finished with mylar strip tape (control).

In our study, the roughest surfaces were obtained with the single-stage Ivoclar Optragloss polishing system in all composites. Although multi-stage Sof-Lex disc polishing system in Tokuyama Omnichroma composite group and two-stage Sof-Lex spiral polishing system in Kuraray Clearfil Majesty Esthetic composite group gave rougher results, the differences between them were statistically insignificant. When our study was evaluated in terms of microhardness; among the different polishing systems, the lowest microhardness values were obtained in the control group finished with mylar strip tape without any polishing process.

It has been reported by many researchers that the use of transparent tape during the construction of composite resin restorations reduces surface roughness values.[34-36] When our study was evaluated in terms of surface roughness; similar to these studies[34-36], the group finished with Mylar strip and used as control group showed the lowest surface roughness values. Since composite resins contain inorganic fillers of different sizes and the filler particles have different degrees of hardness, they produce different surface roughness and different microhardness values after finishing and polishing processes.[37]

Göztaş *et al.*[38] compared surface roughness and microhardness values after polishing using one nanofilament (3M Filtek Supreme XT) and four nanohybrid (Ivoclar Tetric EvoCeram, Dentsply Ceram X, Voco Grandio, Bisco Ælite Enamel) composite resins. They stated that the surface of nanofil composite resin was smoother than nanohybrid composites. And the microhardness values measured in their study were in parallel with the filler ratio; the composite resin material with the highest filler content showed the highest hardness values.

Similar to this study, we used composites with different filler ratios in our study. Tokuyama Estelite Asteria (82% by weight), Tokuyama Omnichroma (79% by weight), Kuraray Clearfil Majesty Esthetic (78% by weight); We obtained the lowest microhardness values in Kuraray Clearfil Majesty Esthetic composite, which is in line with the filler ratio. These results are parallel to the results of the study conducted by Göztaş *et al.*[38] In our study, among supra-nanophile, supra-nano spherical and nano-hybrid composite resin groups; While the smoothest surfaces were seen in the supra-nano spherical composite groups, the roughest surfaces were seen in the nano-hybrid composite groups.

Conclusions

As a result of our study, it was concluded that finishing and polishing processes are effective on surface roughness and microhardness. It can be said that the polishing systems used have different effectiveness on restorative materials with different contents, and Sof-Lex multi-stage disc and Sof-Lex two-stage spiral rubber systems are more successful than the Ivoclar Optragloss system.

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Conflicts of Interest Statement

None.

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Table 1. Composites tested and their composition

Composite	Type	Color	Content	Manufacturer	Ratio W-V
Tokuyama Estelite Asteria	Supra- nanophile composite resin	A2	Bis-GMA Bis-MPEPP TEGDMA UDMA	Tokuyama Tokyo, Japan	82/71
Tokuyama Omnichroma	Supra-nano Sferical composite resin	-	UDMA, TEGDMA, mequinol, Dibutyl hydroxyl toluene, UV absorber	Tokuyama Tokyo, Japan	79/68
Clearfil Majesty Esthetic	Nano hybrid composite resin	A2	Bis-GMA, hydrophobic aromatic dimethacrylate	Kuraray Noritake Dental, Okayama Japan	78/66

Table 2. Material properties and manufacturers of the polishing systems used in the study

Polishing Material	Material properties	Manufacturer
Sof-Lex Polishing Discs	Aluminum oxide coated discs (coarse, medium, fine, super fine)	3M/ESPE, St Paul, Mn, ABD
Sof-Lex Diamond Spiral Tire	Beige colored 2-step spiral tire with aluminum oxide and thermoplastic elastomer content and pink colored diamond particle content	3M/ESPE, St Paul, Mn, ABD
Ivoclar Optragloss	Light blue rubber and spiral rubber with polyurethane, diamond granules	Ivoclar Vivadent, Schaan, Leichtenstein

Table 3. Mean and standard deviation of roughness values of experimental groups (Ra)(SD)

Polisaj Materials	Tokuyama Asteria *Mean (Ra) (SD)*	Tokuyama Omnichroma *Mean (Ra) (SD)*	Kuraray Clearfil Majesty Esthetic *Mean (Ra) (SD)*
Control	0.20 (0.04) ^{a}	0.17 (0.05) ^{d}	0.25 (0.10) ^{e}
Sof-Lex Discs	0.49 (0.14) ^{b}	0.34 (0.08)	0.54 (0.20) ^{f}
Sof-Lex Spiral Tire	0.49 (0.20) ^{c}	0.31 (0.09)	0.57 (0.22) ^{g}
Ivoclar Optragloss	1.02 (0.49)^{A,a,b,c}	0.60 (0.11) ^{A,B,d}	0.95 (0.48)^{B,e,f,g}

F= 13.464, P=0.000 (p<0.05)

^{A,B} In the same line; The same superscript symbolizes groups with differences between the groups indicated by capital letters.

^{a,b,c} In the same column; The same superscript symbolizes groups with differences between the groups indicated by lowercase letters.

Table 4. Average microhardness and standard deviation values obtained in Vickers microhardness tests and statistical evaluations between groups

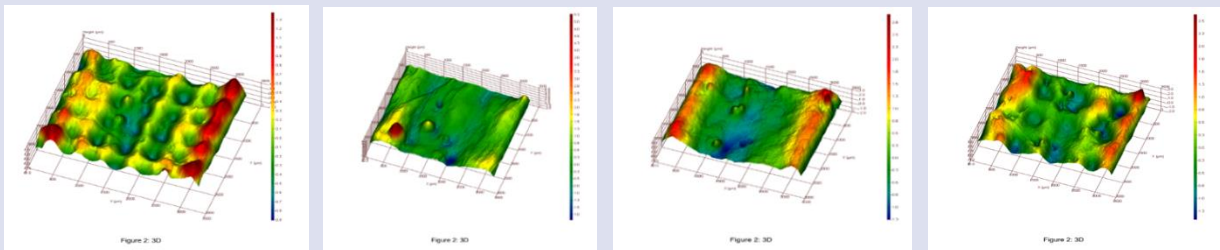
Polishing Systems	Tokuyama Estelite Asteria *Mean (SP)*	Tokuyama Omnichroma *Mean (SP)*	Kuraray Clearfil Majesty Esthetic *Mean (SP)*
Control	83.74 (4.39) ^{A,a,}	88.04 (1.95) ^{A,c}	63.81 (1.88) ^{e,f}
Sof-Lex Discs	108.7 (8.04) ^{b,}	101.1 (7.42) ^{d}	83.05 (5.06)
Sof-Lex Spiral Tire	101.5 (6.9) ^{b,}	92.73 (3.09) ^{c}	67.03 (2.05) ^{e,g}
Ivoclar Optragloss	89.80 (5.91) ^{a,}	100.8 (2.15) ^{d}	68.92 (4.7) ^{f,g}

F= 88.728 P=0.000 (p>0.05)

^{A} In the same line; The same superscript symbolizes groups where there is no difference between the composite groups shown in capital letters.

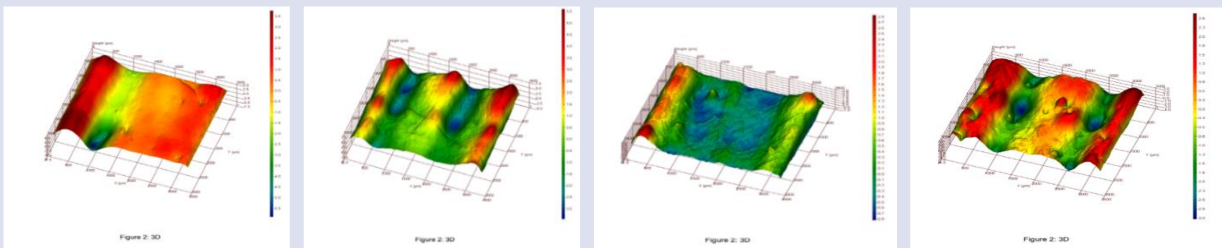
^{a,b,c,d,e,f,g} In the same column; The same superscript symbolizes groups where there is no difference between the polishing groups shown in lowercase letters.

Optical Profilometer Images:



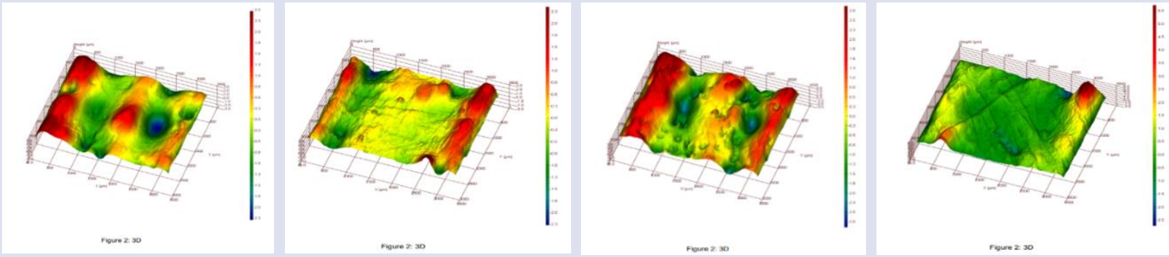
a) Control b) Sof-lex disc c) Sof-lex Spiral d) Ivoclar Optragloss

Figure 1(a.b.c.d.) Optical Profilometer Images of Tokuyama Estelite Asteria Composite



a) Control b) Sof-lex disc c) Sof-lex Spiral d) Ivoclar Optragloss

Figure 2(a.b.c.d.) Optical profilometer images of Tokuyama Omnichroma Composite



a) Control b) Sof-lex disc c) Sof-lex Spiral d) Ivoclar Optragloss

Figure 3(a.b.c.d.) Optical Profilometer Images of Kuraray Clearfil Majesty Esthetic Composite

SEM Images of Tokuyama Estelite Asteria Composite Groups

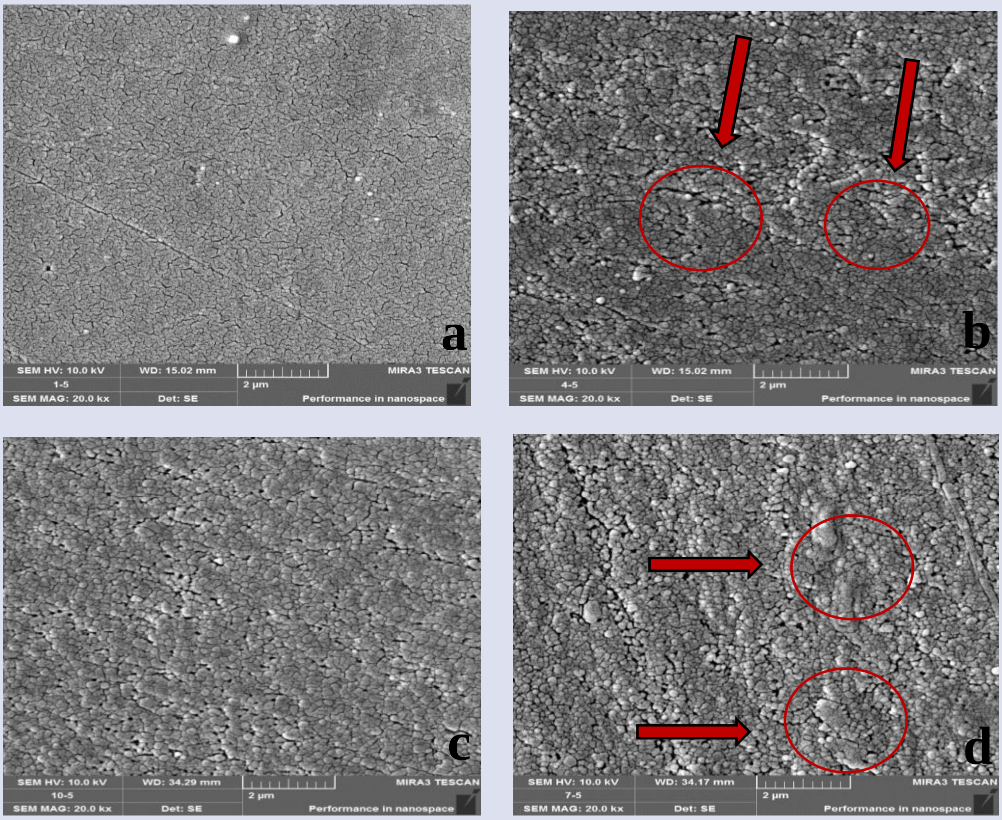


Figure 4. Tokuyama Estelite Asteria SEM images of groups a. control, b. Sof-lex disc, c. Sof-lex Spiral, d. Ivoclar Optragloss.

SEM Images of Tokuyama Omnichroma Composite Groups

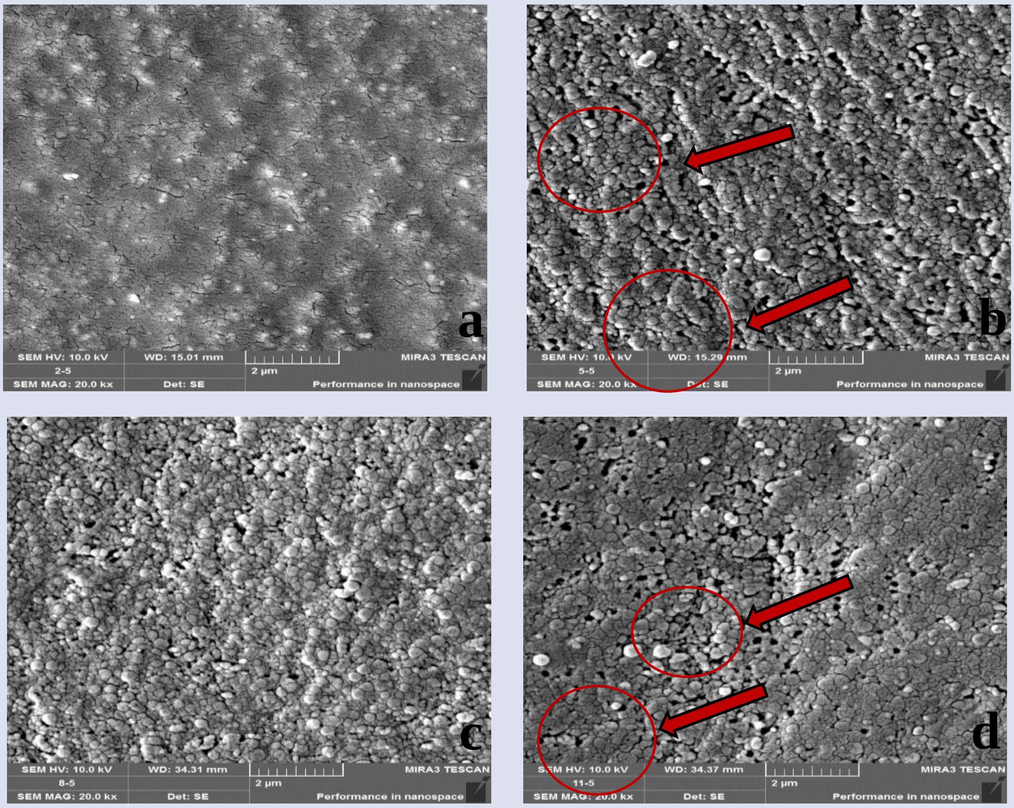


Figure 5. Tokuyama Omnichroma SEM images of groups a. control, b Sof-lex disc, c. Sof-lex Spiral, d. Ivoclar Optragloss.

SEM Images of Kuraray Clearfil Majesty Esthetic Composite Groups

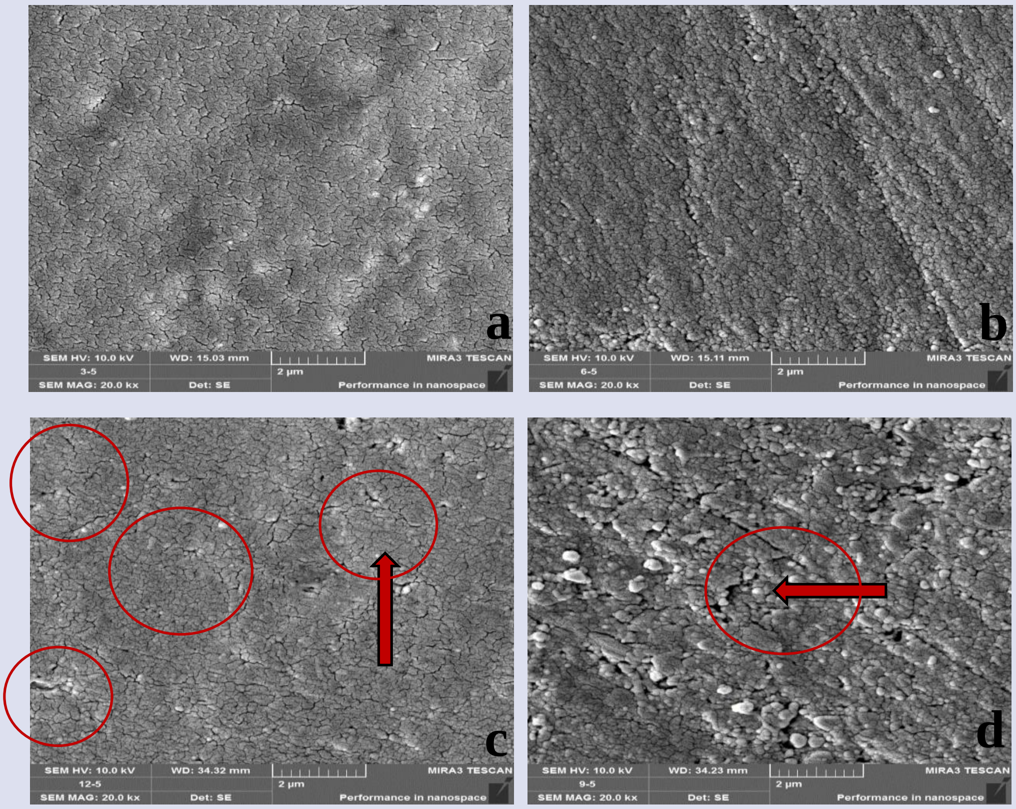


Figure 6. Kuraray Clearfil Majesty Esthetic SEM images of a. control, b. Sof-lex disc, c. Sof-lex Spiral, d. Ivoclar Optragloss groups.