İSTANBUL UNIVERSITY PRESS

RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ
Journal of Advanced Research in Health Sciences / Sağlık Bilimlerinde İleri Araştırmalar Dergisi 2023
DOI: 10.26650/JARHS2023-1253456

# THE EFFECT OF FINISHING AND POLISHING SYSTEMS ON THE SURFACE ROUGHNESS OF INDIRECT COMPOSITE RESINS

# BİTİRME VE CİLA SİSTEMLERİNİN İNDİREKT KOMPOZİT REÇİNELERİN YÜZEY PÜRÜZLÜLÜĞÜNE ETKİSİ

**Hasibe Sevilay BAHADIR[1], İrem ÇETİNBAK[2], Selin POLATOĞLU[3], Çiğdem ÇELİK[4]**

[1] Ankara Yıldırım Beyazıt University, Faculty of Dentistry, Department of Restorative Dentistry, Ankara, Turkiye
[2] Dental Health Center, Sakarya, Turkiye
[3] Private Clinic, Ankara, Turkiye
[4] Kırıkkale University, Faculty of Dentistry, Department of Restorative Dentistry, Kırıkkale, Turkiye

**ORCID ID:** H.S.B. 0000-0001-8577-4408; İ.Ç. 0000-0002-7295-1855; S.P. 0000-0001-8368-277X; Ç.Ç. 0000-0002-5936-0196

**Citation/Atıf:** Bahadir HS, Cetinbak I, Polatoglu S, Celik C. The effect of finishing and polishing systems on the surface roughness of indirect composite resins. Journal of Advanced Research in Health Sciences 2023;6(3):317-322. https://doi.org/10.26650/JARHS2023-1253456

## ABSTRACT

**Objective:** The aim of this study was to evaluate the effects of different types of finishing and polishing systems on the surface roughness of indirect composite resins.

**Materials and Methods:** In this study, 2 indirect composite resins (Gradia Plus (GC Inc., Kyoto, Japan, and Ceramage, SHOFU Inc., Kyoto, Japan) and 2 direct composite resins (FiltekZ250, 3M ESPE, St. Paul, USA and GradioSO, VOCO GmbH, Cuxhaven, Germany) were used. A total of 144 discs specimens were prepared. The specimens were randomly divided into 3 subgroups (n=12). Group K: Mylar Strip Band (Control), Group L: Silicone Polisher (Nais, Sofia, Bulgaria), Group D: Super Snap disc (SHOFU, Kyoto, Japan) polishing systems were used. The surface roughness of the specimens was measured using a profilometer (Surftest-211, Kanagawa, Japan). The data were analyzed statistically ($p<0.05$).

**Results:** The Mylar strip band surface (control) was measured as the smoothest surface in all groups. While the roughest surface measured was polishing with silicone polishers. ($p<0.05$). While there is no significant statistical difference between the Mylar strip band and yellow rubber polishing system in all materials, a significant difference was found in the Super Snap polishing disc system between Filtek Z250 and Ceramage material ($p=0.002$).

**Conclusions:** In this study, both the polishing systems used and the materials used had an effect on the surface roughness of indirect resin composites.

**Keywords:** Indirect composite resin, polishing systems, surface roughness

## ÖZ

**Amaç:** Bu çalışmanın amacı; farklı tipteki bitirme ve cila sistemlerinin indirekt kompozit reçinelerin yüzey pürüzlülüğüne etkisini incelemektir.

**Gereç ve Yöntem:** Bu çalışmada 2 indirekt kompozit rezin (Gradia Plus, GC Inc., Kyoto, Japonya) ve Ceramage (SHOFU Inc., Kyoto, Japonya) ve 2direkt kompozit rezin (FiltekZ250 (3M ESPE, St. Paul, ABD) ve GradioSO (VOCO GmbH, Cuxhaven, Almanya) kullanılmıştır. Toplam 144 adet disk şeklinde örnek hazırlandı. Örnekler rastgele 3 alt gruba ayrıldı (n=12). Grup K: Mylar Strip Band (Kontrol), Grup L: Silikon Parlatma Lastiği (Nais, Sofia, Bulgaristan), Grup D: Super Snap disk (SHOFU, Kyoto, Japonya) polisaj sistemi kullanıldı. Örneklerin yüzey pürüzlülük ölçümü profilometre (Surftest-211, Kanagava, Japonya) kullanılarak ölçüldü. Elde edilen veriler istatistiksel olarak analiz edildi ($p<0,05$).

**Bulgular:** Bütün gruplarda istatistiksel olarak anlamlı şekilde Mylar strip band altı yüzey (kontrol) en pürüzsüz yüzey olarak ölçülürken; en pürüzlü yüzey silikon parlatma lastiğiyle yapılan cilada ölçülmüştür. ($p<0,05$). Bütün materyallerde Mylar strip band ve silikon lastik cila sistemi arasında istatistiksel olarak anlamlı bir fark görülmezken; Filtek Z250 ve Ceramage materyali arasında Super Snap cila disk sisteminde anlamlı fark bulunmuştur ($p=0,002$).

**Sonuçlar:** Bu çalışmada, indirekt kompozit reçinelerin yüzey pürüzlülüğüne hem kullanılan polisaj sistemlerinin hem de materyallerin etkisi olmuştur.

**Anahtar Kelimeler:** İndirekt kompozit reçine, cila sistemleri, yüzey pürüzlülüğü

**Corresponding Author/Sorumlu Yazar:** Hasibe Sevilay BAHADIR **E-mail:** sevilay.bahadir@hotmail.com

**Submitted/Başvuru:** 20.02.2023 • **Revision Requested/Revizyon Talebi:** 01.05.2023 • **Last Revision Received/Son Revizyon:** 01.05.2023 • **Accepted/Kabul:** 01.05.2023 • **Published Online/Online Yayın:** 10.10.2023

## INTRODUCTION

Nowadays, the demand for tooth-colored restorations continues to increase in direct proportion to the aesthetic expectations of the patients. Composite resins are the first-choice materials for direct restorations by clinicians (1). Indirect composite resin restorations are also used in restorative dentistry to overcome some of the disadvantages seen in direct composite restorations, such as polymerization shrinkage and difficulties in obtaining an ideal proximal contact and anatomical form (2-4). Indirect composite resins (inlay, onlay, overlay, etc.) are composite restorations prepared in laboratories. The indirect composite inlay technique was introduced in the early 1980s and first-generation indirect composites were produced thanks to this technique. First-generation indirect composites have advantages such as ease of fabrication, adequate marginal adaptation, reduced polymerization shrinkage, and adequate proximal contact. Despite these advantages, first-generation composites have microfill filler content and have been shown to have disadvantages such as marginal and isthmus fractures under heavy occlusal loads, occlusal wear, and poor color stability. In the mid-1990s, a second generation of indirect composites was produced by Touati (3-5). The clinical performance of second-generation indirect composite resins was found to be better than first-generation composites, as they have improved mechanical properties with a high filler content of 60-70% (3-5). For the polymerization of indirect composites used in laboratories, special devices containing light, heat, pressure, or a combination of these have been produced. This method of polymerization increases the durability and longevity of composites (5).

For a good composite restoration, in addition to the composite resin properties, finishing and polishing processes are also of great importance (6). Proper finishing and polishing of restorative materials are very important procedures that increase the aesthetic properties and the clinical life of restorations. The composite resin's organic matrix and inorganic filler types, particle sizes and amounts, technique and the tools used affects the surface structure of the restoration and determine its polishability. The difference in hardness between inorganic filler particles and organic matrices causes the surface to remain rough after polishing. Inorganic filler particles are harder and have less wear than organic matrix (6-8). The surface of a rough restoration increases plaque accumulation which results in gingival inflammation, surface discoloration, and discoloration in the restoration. In addition, an increase in friction coefficient and wear rate is observed on rough surfaces. Therefore, a smooth surface is a crucial factor for the long-term clinical performance of restorations (7). Also, a smooth surface contributes to patient comfort, as a 0.2-0.3 µm change in surface roughness can be detected with the tip of the tongue (8).

While finishing means removing the irregularities at the finishing border of the restoration and creating anatomical contours in order to obtain the desired anatomy, polishing means reducing the roughness created by the finishing tools and removing the scratches (6). Composite resins polymerized against clear tape will have the smoothest possible surface, although not devoid of surface imperfections. Although this surface is rich in an organic matrix, this layer must be removed by finishing and polishing operations. At the same time, with these finishing and polishing processes, excess materials are removed and restorations are reshaped (7).

One of the most important purposes of restorative dentistry practices is to make restorations with the closest physical properties to the tooth tissue. It is the aim of well-finished and polished restorations to have a surface similar to the enamel tissue. In order to obtain a smooth surface, there are carbide and diamond burs, white stones, polishing rubbers and discs, tapes, aluminum oxide, or diamond-containing rubber and pads on the market. However, properties such as the structure, filler content, and type of composite resins affect the success of the finishing and polishing processes (9).

According to the literature, there are many studies examining the effects of polishing systems on the surface roughness of composite resins (7,10-14). However, there are a limited number of studies examining the surface roughness of structurally developed indirect composite resins, the usage areas of which are gradually expanding (15,16).

The aim of this in-vitro study was to evaluate the effects of different polishing systems on the surface roughness of indirect composite resins. The null hypothesis of this study was different polishing systems do not affect the surface roughness of indirect composites.

## MATERIALS and METHODS

In this study, 2 different indirect composite resins, Gradia Plus (GC Inc., Kyoto, Japan) and Ceramage (SHOFU Inc., Kyoto, Japan), and two different direct composite resins FiltekZ250 (3M ESPE, St. Paul, USA) and GradioSO (VOCO GmbH, Cuxhaven, Germany) were used. Table 1 shows the manufacturer and material contents.

The required minimum number of specimens for the study was calculated using G*Power v.3.1 software (Heinrich, Düsseldorf, Germany), based on an alpha level of 0.05 (type I error), effect size of 0.4, and beta power of 0.90 (1 - type II error). The estimated minimum number of specimens for each group was determined to be 12. In this study, a total of 144 specimens of 2 mm height and 6 mm diameter were prepared, 36 specimens of each restorative material. After the composite resin was placed on the plastic molds, the upper surface was covered with Mylar strip tape and compressed with a glass plate to obtain a smooth surface. Then, the direct composite resins were light-cured for 20 seconds using an LED light device (Elipar S10, 3M ESPE, St. Paul, USA). To complete the polymerization of the indirect composite resins, the specimens were placed in a laboratory light-curing device (GC LABOLIGHT LV-III, GC, Tokyo, Japan) for 3 minutes according to the manufacturer's instructions. After polymerization, all samples were removed from the

**Table 1:** Materials, ingredients and manufacturers used in the study

| Material | Manufacturer | Material type | Ingredients | Lot number |
|---|---|---|---|---|
| **Gradia Plus,** (Indirect composite) | GC Inc., Kyoto, Japan | Microhybrid | UDMA, EDMA (weight 75% filler: Ceramic, Prepolymer, SiO2) | 1901151 |
| **Ceramage** (Indirect Composite) | SHOFU Inc., Kyoto, Japan | Microhybrid | UDMA, UDA, zirconium silicate (weight 73% filler), Pigments and others. | 121828 |
| **GradioSO** (Direct Composite) | VOCO GmbH, Cuxhaven, Germany | Nanohybrid | Resin matrix: bis-GMA, TEGDMA, bis-EMA Filler: 1 µ glass ceramic fillers with 20–40 nm silicon dioxide nanoparticles. 89% filler by weight. | 1921607 |
| **Filtekz250** (Direct Composite) | 3M ESPE, St. Paul, MN, ABD | Microhybrid | Organic matrix: TEGDMA < 1–5%; Bis-GMA < 1–5%; Bis-EMA 5–10%; UDMA 5–10% Filler: Zirconium/silica; 60% volume inorganic filler | NA14156 |
| **Super Snap Disc Set (Aluminum oxide coated discs)** | SHOFU Inc., Kyoto, Japan | Polishing disc | Aluminum oxide | 0321017 |
| **Silicon Rubber** | Nais Ltd, Sofia, Bulgaria | Polishing rubber | Fine grain silicon particle | 1002F082017563 |

BisGMA: Bisphenol A diglycidyl ether dimethacrylate, BisEMA: Bisphenol A Polyethylene Glycol Diether Dimethacrylate, TEGDMA: Triethylene Glycol Dimethacrylate, UDMA: Diurethane Dimethacrylate, SiO2: Silicon diooxide, EDMA: Ethyleneglycoldimethacrylate

plastic mold and kept in distilled water at 37 °C for 24 hours. All specimens were then divided into 3 different groups (n=12) according to finishing polishing procedures. All specimens except for the control group (Mylar strip) were ground-finished, respectively, with 400, 800, and1200 grit silicon carbide abrasive paper (English Abrasives, UK) on a sanding machine (Phoenix Beta, Buehler, Illinois, USA) and subjected to water cooling (300 revs/min, during 5 s) before polishing. A low-speed handpiece at a maximum of 12000 rpm was used with a continuous repetitive tapping motion. The polishing disc system was used in 4 stages coarse, medium, fine, and extra-fine-grained, with 6 strokes at each stage [12]. After each polishing disc stage, the specimens were thoroughly rinsed with water for 10 seconds to remove any residue on them and air-dried for 5 seconds. The polishing discs were renewed after every 5 samples. All operations were performed by a single operatör (Hasibe Sevilay BAHADIR) to reduce variability.

The groups were divided for each composite resin as follows:

Group K: (Control) (Mylar strip)

Group L: Silicone rubber

Group D: Super-Snap Polishing Disc

The polished composite resin samples were washed, left to dry, and kept at 100% humidity for 24 hours before measuring the average surface roughness values (Ra). The surface roughness test was performed using a contact profilometer (Surftest-211, Mitutoyo; Kanagawa, Japan) moved at a constant speed of 0.05 mm/s with a cut-off value of 0.25 mm. Three random measurements were made on each surface and the average Ra was calculated.

Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) version 18 was used for data analysis. Whether the data were normally distributed or not was determined by the Shapiro-Wilk test. Also, the data were controlled with a Levene's Test for equality of variances. Data were statistically analyzed with a two-way analysis of variance (ANOVA), multiple comparisons were made with the Tukey post hoc, and pairwise comparisons were made with the Bonferroni test at a significance level of 0.05.

## RESULTS

Table 2 shows the average surface roughness values (Ra) of composite resins after polishing. In all groups, the surface under the mylar strip (control) was measured as the smoothest surface. Following this, the Super Snap polishing system was measured to be rougher than the mylar strip and finally, the roughest surface measured was polishing made with silicone rubber ($p<0.05$). While there was no significant statistical difference between the materials, Mylar strip, and silicone rubber system. A significant difference was found in the Super Snap polishing disc system between Filtek Z250 and Ceramage material ($p=0.002$), (Table 2).

## DISCUSSION

Finishing and polishing processes are an important step that directly affects the aesthetic properties and life of composite resins, and finishing and polishing using a minimum amount of time and tools is clinically important (7). In this study, it was investigated whether polishing systems with different properties would affect the surface roughness (Ra) of different types of composite resins, and the null hypothesis examined based on the results of the study were rejected.

**Table 2:** Average surface roughness(Ra) + standard deviation values of groups

| Restorative Materials | Mylar (Control Group) | Silicon Rubber | Super Snap Disc | p |
|---|---|---|---|---|
| **Ceramage** | 0.163±0.028[a] | 0.612±0.028[b] | 0.561±0.028[c#] | .000 |
| **Gradia Plus** | 0.110±0.028[a] | 0.658±0.028[b] | 0.474±0.028[c] | .000 |
| **GrandioSO** | 0.093±0.028[a] | 0.595±0.028[b] | 0.453±0.028[c] | .000 |
| **Filtek Z250** | 0.102±0.028[a] | 0.730±0.028[b] | 0.388±0.028[c#] | .000 |

While statistical differences in the groups on the same line are shown with different letters ([a, b, c]), statistical differences in the same column are indicated by the symbol ([c] and [c#]) (p<0.05).

In this study, different types of indirect and direct composites were used. In order to ensure clinical standardization, all groups except the Mylar strip surface (control group) were sanded under water with 1200 grid silicon carbide papers before the finishing process (9,13). The findings were found to be compatible with the results of many studies. In the studies conducted by Tuncer et al., Antonson et al., Korkmaz et al., Duraes et al., and Baseren; The polymerized composite surface under the Mylar strip band was determined as the smoothest surface (9, 10, 13, 15, 17). Even though, a low roughness surface is obtained in composite resins made with Mylar strip; this surface is rich in organic matrix. Therefore, this layer must be removed by finishing and polishing operations. This will result in a harder, wear-resistant surface (18).

When polishing systems are compared with each other; In all materials, surfaces polished with the Super Snap disc system were statistically significantly smoother than surfaces polished with silicone rubber. Even though there was no significant statistical difference Ceramage indirect composite material polished with a super snap disc system was found to be rougher than Gradia Plus, and even though there was no significant statistical difference ($p>0.05$). Ceramage indirect composite material polished with silicone rubber polishers was found to be smoother than Gradia Plus. GradioSO direct composite material Filtek Z250 polished with Super Snap disc system has a rougher surface, although there is no statistical difference compared to direct composites; GradioSO direct composite material, which was polished with silicone rubber, was found to have a less rough surface, although there was no statistical difference compared to Filtek Z250 direct composite. The roughness of the surfaces obtained by polishing depends on the efficiency, geometry, flexibility, applied pressure, application time, and particle hardness of the systems used for polishing (18).

In order for the polishing systems to be effective on the composite resin surface; the abrasive particles must be harder than the fillers of composite resins. If the abrasive particles in the polishing system are softer than the fillers in composite resins, only the soft resin matrix of the composites will disappear, causing the filler particles to break off from the surface (11, 18). Discs impregnated with aluminum oxide particles, one of the polishing systems, have the same lifting capacity as filler particles and resin matrix. However, this polishing system has limitations due to its geometry. It can be difficult to anatomically finish and polish restorations in the posterior region, especially on contoured surfaces (19). Bilgili et al., Lu et al., and Venturini et al., concluded in their studies that aluminum oxide discs are the best material to provide smoother surfaces in composite resins (18, 20, 21). In our study, a Super Snap disc system containing aluminum oxide was found to be the best polishing method. At the same time, the highest surface roughness was found in silicone rubber containing silicon particles. This is because silicon particles do not have harder abrasives than filler particles of composite resins such as diamond or aluminum oxide particles. Therefore, silicone rubbers are not sufficient for effective finishing and polishing (11). Although there is no statistical difference, polishing with a Super Snap disc may be clinically preferable for Filtek Z250 and Gradia Plus materials. Likewise, polishing with silicone rubber may be clinically preferable for Ceramage and GradioSO materials, although there is no statistical difference.

In recent years, single or two-stage polishing systems have been developed to reduce both the application phase and the application time clinically. In addition to these advantages of single-stage systems, minimizing the risk of cross-infection also makes them more clinically preferred (9,12). Different results have been obtained in studies on single or multi-stage polishing systems. While Yap et al., and St- Georges et al., found similar surface roughness values obtained with single or multi-stage systems in their studies; Tuncer et al., Aytac et al., Bilgili et al., and Uctasli et al., found that multi-stage polishing systems have lower surface roughness values than single-stage polishing systems (9, 11, 18, 22, 23, 24). In our study, single-stage silicone polishing rubber and multi-stage Super Snap Disk systems were compared, and the multi-stage polishing system was found to be more successful.

For composite resins, the roughness value after polishing is required to be below 0.2 µm. It has been observed that the adhesion of bacterial species and the risk of secondary caries are reduced on restorations with a value of less than 0.2 µm (11). In a clinical study conducted by Aytac et al., it was determined that the patients were able to notice an average roughness value of 0.3 µm. (11). The surface roughness value for all composite resin types was found to be higher than 0.3 µm for the finishing and polishing systems used in this study.

In this study, when composite resin types were compared, a statistical difference was observed between the surface roughness of Filtek Z250 and Ceramage composite resin types polished only with Super Snap. Filtek Z250 composite material was found to be smoother. Duraes et al., in a study they carried out, they examined the effect of different polishing systems on the surface roughness of Ceramage indirect composite resin and they found the highest surface roughness in the silicone rubber polishing system (15). Korkmaz et al., in a study they conducted, investigated the effect of different polishing systems on the surface roughness of direct composite resins Grandio and Filtek Z250 and found that Filtek Z250, which was polished with an aluminum oxide-containing polishing system, was statistically smoother than Grandio (13).

Ersöz et al., in another study they conducted, they examined the effect of a polishing system containing diamond particles on the surface roughness of GrandioSO and Gradia Plus materials and found the surface roughness of both materials to be similar (16). The surface roughness of composite resin materials depends on the structure of the composite material as well as the finishing and polishing systems used (14,25). One of the many factors affecting the surface properties of composite resins is the filler size. At the same time, the type, shape, amount, and bonding of the filler particles to the resin matrix affect the clinical performance of composite resins (11). Composites with harder and larger filler particles show higher Ra values after finishing and polishing (9). While the filler particle ratio of Ceramage, the indirect composite used in this study, was 73%; Filtek Z250, which is a direct composite, has a filler particle ratio of 60%. While a higher filler ratio provides a better mechanical property; it can damage the aesthetics of the material and make it difficult to polish (15). When we examine the literature, while Endo et al., reported that the polishing system had an effect on the surface roughness in their study, Bashetty et al., reported that the material had an effect on the surface roughness in their study (12, 26). In their study, Marghalani et al., reported that both the material and the polishing system had an effect on surface roughness (27). In this study, in accordance with the study of Marghalani et al., both the polishing systems used and the materials had an effect on the surface roughness.

This study has several limitations. Profilometer is used to measure surface roughness in in-vitro studies. However, two-dimensional data is obtained with the profilometer; Three-dimensional information is not available. Obtaining surface roughness with only a profilometer is one of the limitations of this study. Another limitation is that polishing systems with different abrasive content are not used. There is also a need for long follow-up clinical studies that mimic the oral environment.

## CONCLUSION

Within the limitations of this study, the following conclusions were reached:

The lowest surface roughness was found in the Super Snap polishing system in all materials except the control group.

Filtek Z250 group, in which a Super Snap polishing system is used, has a lower surface roughness than the Ceramage group.

The results of this study present different options for dentists in choosing the appropriate finishing and polishing techniques for clinical application.

---

**Ethics Committee Approval**: Ethics Committee approval is not required for this study.

**Peer Review**: Externally peer-reviewed.

**Author Contributions**: Conception/Design of Study- H.S.B., S.P., İ.Ç., Ç.Ç.; Data Acquisition- H.S.B., S.P., İ.Ç., Ç.Ç.; Data Analysis/Interpretation- H.S.B., S.P., İ.Ç., Ç.Ç.; Drafting Manuscript- H.S.B., S.P., C.Ç.; Critical Revision of Manuscript- H.S.B., C.Ç., İ.Ç.; Final Approval and Accountability- H.S.B., S.P., İ.Ç., Ç.Ç.; Material and Technical Support- H.S.B., C.Ç.; Supervision- H.S.B., C.Ç.

**Conflict of Interest:** The authors have no conflict of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

## REFERENCES

1. Kirmali O, Barutcugil C, Harorli O, Kapdan A, Er Kursat. Resin cement to indirect composite resin bonding: Effect of various surface treatments. Scanning 2015;37(2):89-94.
2. Visuttiwattanakorn P, Suputtamongkol K, Angkoonsit D, Kaewthong S, Charoonanan P. Microtensile bond strength of repaired indirect resin composite. J Adv Prosthodont 2017;9(1):38-44.
3. Souza EM, Francischone CE, Powers JM, Rached RN, Vieira S. Effect of different surface treatments on the repair bond strength of indirect composites. Am J Dent 2008;21(2):93-6.
4. Kimyai S, Oskoee SS, Mohammadi N, Rikhtegaran S, Bahari M, Oskoee PA, et al. Effect of different mechanical and chemical surface treatments on the repaired bond strength of an indirect composite resin. Lasers Med Sci 2015;30(2):653-9.
5. Karaarslan ES, Ertas E, Bulucu B. Clinical evaluation of direct composite restorations and inlays: Results at 12 months. J Rest Dent 2014;2(2):70-77.
6. Ölmez A, Kisbet S. Kompozit rezin restorasyonlarda bitirme ve polisaj işlemlerindeki yeni gelişmeler. Acta Odontol Turc 2012;30(2):115-22.
7. Choi M-S, Lee Y-K, Lim B-S, Rhee S-H, Yang H-C. Changes in surface characteristics of dental resin composites after polishing. J Mater Sci 2005;16(4):347-53.
8. Ergücü Z, Türkün L. Surface roughness of novel resin composites polished with one-step systems. Oper Dent 2007;32(2):185-92.
9. Tuncer D, Halaçoğlu DM, Çelik Ç, Arhun N. Bitirme ve Parlatma Sistemlerinin Farklı Tipteki Kompozit Rezinlerin Yüzey Pürüzlülüğüne Etkisi. 7tepe Klinik Dergisi 2016;12(2):25-30.
10. Antonson SA, Yazici AR, Kilinc E, Antonson DE, Hardigan PC.

Comparison of different finishing/polishing systems on surface roughness and gloss of resin composites. Int J Dent 2011;39(Suppl 1):e9-17.

11. Aytac F, Karaarslan ES, Agaccioglu M, Tastan E, Buldur M, Kuyucu E. Effects of novel finishing and polishing systems on surface roughness and morphology of nanocomposites. J Esthet Restor Dent 2016;28(4):247-61.
12. Bashetty K, Joshi S. The effect of one-step and multi-step polishing systems on surface texture of two different resin composites. J Conserv Dent 2010;13(1):34-8.
13. Korkmaz Y, Ozel E, Attar N, Aksoy G. The influence of one-step polishing systems on the surface roughness and microhardness of nanocomposites. Oper Dent 2008;33(1):44-50.
14. Ozel E, Korkmaz Y, Attar N, Karabulut E. Effect of one-step polishing systems on surface roughness of different flowable restorative materials. Dent Mater J 2008;27(6):755-64.
15. Durães I, Macêdo GL, Carvalho CF, Oliveira VMB, Lima EMCX. Effects of different polishing systems on the surface roughness of two ceromers. Bra Dent Sci 2016;19(2):56-63.
16. Ersöz B, Karaoğlanoğlu S, Oktay EA, Aydın N. Color stability and surface roughness of resin based direct and indirect restorative materials. E An Dent Sci 2021;48(1):1-6.
17. Baseren M. Surface roughness of nanofill and nanohybrid composite resin and ormocer-based tooth-colored restorative materials after several finishing and polishing procedures. J Biomater Appl 2004;19(2):121-34.
18. Bilgili D, Dündar A, Barutçugil Ç, Öcal İB. Farkli cila sistemlerinin kompozit rezinlerin yüzey pürüzlülükleri üzerine etkisi. 7tepe Klinik Dergisi 2020;16(2):147-53.
19. Turkun L, Turkun M. The effect of one-step polishing system on the surface roughness of three esthetic resin composite materials. Oper Dent 2004;29(2):203-11.
20. Lu H, Roeder LB, Powers JM. Effect of polishing systems on the surface roughness of microhybrid composites. J Esthet Restor Dent 2003;15(5):297-304.
21. Venturini D, Cenci MS, Demarco FF, Camacho GB, Powers JM. Effect of polishing techniques and time on surface roughness, hardness and microleakage of resin composite restorations. Oper Dent 2006;31(1):11-7.
22. Yap AU, Yap S, Teo C, Ng J. Finishing/polishing of composite and compomer restoratives: effectiveness of one-step systems. Oper Dent 2004;29(3):275-9.
23. St-Georges AJ, Bolla M, Fortin D, Muller-Bolla M, Thompson JY, Stamatiades PJ. Surface finish produced on three resin composites by new polishing systems. Oper Dent 2005;30(5):593-7.
24. Uctasli M, Arisu HD, Omurlu H, Eliguzeloglu E, Ozcan S, Ergun G. The effect of different finishing and polishing systems on the surface roughness of different composite restorative materials. J Contemp Dent Pract 2007;8(2):89-96.
25. Erdemir U, Yildiz E, Eren MM, Ozsoy A, Topcu FT. Effects of polishing systems on the surface roughness of tooth-colored materials. J Dent Sci 2013;8(2):160-9.
26. Endo T, Finger WJ, Kanehira M, Utterodt A, Komatsu M. Surface texture and roughness of polished nanofill and nanohybrid resin composites. Dent Mater J 2010;29(2):213-23.
27. Marghalani HY. Effect of finishing/polishing systems on the surface roughness of novel posterior composites. J Esthet Restor Dent 2010;22(2):127-38.