COMPARATIVE STUDY REGARDING SOURFACE ROUGHNESS OF DIFFERENT TYPES OF COMPOSITE RESINS AFTER FINISHING AND POLISHING METHODS AND GLAZE MATERIAL APPLICATION

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ABSTRACT

Surface roughness is the major contributor for extrinsic discoloration of resin composite restorations. This property is closely related to the organic matrix, inorganic filler composition of the composite, and finishing and polishing procedures. Rough surface greater than 0.2 µm provides higher chances of biofilm accumulation, leading to staining and/or discoloration of the restoration's body or margins. The purpose of the study was to compare the finishing and polishing technique of some composite resins with their sealing using a glaze material type, in terms of surface roughness. Materials and methods: 45 composite specimens were manufactured(ormocer- ADMIRA, nanohybrid – TETRIC EVOCERAM, nanocomposite – FILTEK ULTIMATE), and divided into 3 groups(n=15, control, polished and finished, and glaze material). Roughness(Ra) was messured before and after immersing in artificial saliva. For all composite resins the sourface roughness decreased after 90 days.

Key words: Surface roughness, Composite resins, Finishing and polishing methods.

INTRODUCTION

Composite materials have become some of the most used in restorative dentistry due to their aesthetic features and mechanical properties. Over time, composite resins have been classified according to different criteria, but the most important of these was their filling load. Analyzing their evolution over time, we noticed how they passed the macrofiller (classical composites with particles larger than 1 µm) to microfilters (particle size 0.002-0.04µm) and hybrid (0.6-1.0µm) to microhybrid, and the most new types of composite resins available on the market are nanofiller (20-75 µm) and nanoceramic [1]. An important factor in the success of a composite restoration is the finishing of the surfaces. Obtaining a smooth, glossy surface was considered a major objective to be met, not only for aesthetic reasons, but also for oral health. The incomplete finishing of the restored surfaces can lead to the accumulation of dental plaque, gingival inflammation, periodontal problem, demineralization of the dental hard structure, appearance of stains or even caries adjacent to composite resin restorations [1, 2]. Finishing of composite resins refers to coarse contouring and rendering of the desired anatomy, while polish refers to the reduction of roughness and the removal of scratches created by finishing tools [3]. The final finishing of the composites depends on the particle size of the material, the filling load, the quality and, last but not least, the polish material used [4]. Composite resins respond differently to polishing and finishing mechanisms, since they are made from different components and do not have the same properties in hardness [5]. The existence on the dental products market of numerous techniques and technologies for the finishing and polishing of composite resins gives us the opportunity to choose the best variant for each type of composite used. Thus we can find silicone disks, cups with different types of abrasives, soap-lex impregnated brushes, abrasive strips, rotary diamond tooling, polishing paste, etc. The use of finishing and polishing methods of a composite resin restoration made according to a particular protocol may vary between 10 and 30 minutes, which is why the glaze materials that seals the composite restorations is increasingly used, eliminating

the final finishing and mechanical polishing steps, and provide a natural gloss for the filling. In recent years, numerous studies have been carried out to determine the best finishing and polishing system on different types of composites, the effects of polish systems have been reported to be material-dependent and their effectiveness as being dependent on the product used.

AIM. The purpose of the study was to compare the finishing and polishing technique of some composite resins with their sealing using a glaze material type, in terms of surface roughness.

MATERIALS AND METHODS

45 composite specimens were manufactured(ormocer- ADMIRA, nanohybrid – TETRIC EVOCERAM, nanocomposite – FILTEK ULTIMATE), with a diameter of 10 mm and a thickness of 4 mm, by composing a transparent plastic mold placed on a glass plate and light-cured with a Kerr Demi Plus LED lamp Wavelengths of 450 - 470 nm) (Tabel 1).

Materials used	Comercial product	Series	Filler average	Manufacturer
NANO-HYBRID Bis-Gma, UDMA,	Tetric Evoceram	V16178	The total content of inorganic fillers for the Bleach shades is 79–80 wt.% or 60–61 vol.% , for all the other shades 75–76 wt.% or 53–55 vol.%. The particle sizes of the inorganic fillers range between 40 nm and 3 µm.	Ivoclar Vivadent
NANO-COMPOSITE Bis - GMA,UDMA,TEGDMA, bis-EMA volume)	Filtek Ultimate	N788909	non-agglomerated/non-aggregated 20 nm silica filler, non-agglomerated/non-aggregated 4 to 11 nm zirconia filler, and aggregated zirconia/silica cluster filler (comprised of 20 nm silica and 4 to 11 nm zirconia particles).	3M ESPE Dental Products, St. Paul, MN, USA
ORMOCER Organic Modified Ceramics 3-dimensionally linked inorganic-organic co-polymers (Ormocer®s) and additive aliphatic and aromatic dimethacrylates	Admira Fusion	1536641	78 % inorganic filler material (= 56 % microfillers by volume, ca. 0.7 µm).	Voco
GLAZE MATERIAL	Seal – and - Shine		Uncured acrylate ester Monomers 55-60% Silica, amorphous 5 % Sodium fluoride <1%	PULPDENT, USA

The 45 composite discs were divided into 3 groups as follows:

- Group 1 (n=15) – control group – no finishing and polishing methods was apllyed and the polymerization was done under a Mylar band to avoid unevenness

- Group 2 (n=15) composite finished according to a predetermined protocol that included the following steps: 1. Finishing with special finishing composite burs (NTi), 2. Sof- Lex in combination with the diamond particle paste 1 µm (Ultradent), 4. Non-impregnated filts (TDV) in combination with 0.5 µm diamond paste (Ultradent), 5. Non-granular polyethylene (NTI) and 0.5 µm diamond paste (Ultradent).

- Group 3 (n=15) for which, after the photopolymerization of the composite, it

was coated with lacquer glaze (Seal and Shine - Pulpdent, USA) by applying it with the help of a brush and subsequent curing according to the manufacturer's indications.

All the finishing and polishing, and sealing procedures were performed by a single practitioner and in accordance with the manufacturer's instructions. Thus, finishing with special burs was done at conventional speeds that do not exceed 20,000 revolutions, under continuous water irrigation. For each specimen, a new finishing gum was used at 7000 rpm for 10 seconds. Sof-lex (3M) spiral diamond spheres were used at 15,000 rpm for 10 seconds. The filts were used at low revs, 2000 rpm, 10-15 seconds, and the gravelless gravel at 4500t / min, 20 seconds.

The specimens were analyzed using the Talysurf Intramural Form Trimmer, through which the roughness (Ra) was determined. After the profilometric analysis, the specimens were immersed in the artificial saliva (Afnor) for 90 days. Profilemetry was resumed at 90 days. Three measurements were made for each specimen and the mean value was used as the Ra value of the specimen. We compared, in turn, the specimens in finished and polished group, and glazed group with control group.

Statistical analysis vas performed using ANOVA test. For Ra values, paired samples *t*-tests were used to analyze the data and compare groups.

RESULTS

Tabel 2 provides the Ra values for each material immediately after the surface treatments. A significant difference was observed among the finishing-polishing procedures ($p<0.05$) and glaze material application, related to control group.

Tabel 2. Surface roughness (Ra, µm) ± standard deviations of esthetic restorative materials (immediately after the surface treatments)

Restorative materials	CONTROL GROUP(G1)	FINISHING AND POLISHING METHODS (G2)	GLAZE MATERIAL APLLICATION (G3)
TETRIC EVOCERAM	0.26±0.03	0.36±0.05	0.33±0.02
FILTEK ULTIMATE	0.23±0.02	0.34±0.03	0.30±0.04
ADMIRA FUSION	0.25±0.06	0.38±0.04	0.35±0.06

Tabel 3 provides the Ra values for each material 90 after the surface treatments.

ANOVA test is used to compare if between the values determinated for the specimens immediately and after 90 days of saliva immersion there are significant differences. The Ra values decreased after the time sped in artificial saliva for all composite resins. As we cand see in ANOVA Tabel the *F* value(6.9875) is higher that *F crit (*5.14325285) which shows that between the registered values of roughness there are statistically significant differences.

Tabel 3. Surface roughness (Ra, µm) ± standard deviations of esthetic restorative materials (90 days after the surface treatments)

Restorative materials	CONTROL GROUP(G1)	FINISHING AND POLISHING METHODS (G2)	GLAZE MATERIAL APLLICATION (G3)
TETRIC EVOCERAM	0.25±0.02	0.31±0.03	0.28±0.03
FILTEK ULTIMATE	0.22±0.04	0.29±0.01	0.26±0.04
ADMIRA FUSION	0.24±0.03	0.33±0.03	0.29±0.03

ANOVA Tabel

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.012422222	2	0.006211111	6.9875	0.027102	5.14325285
Within Groups	0.005333333	6	0.000888889			
Total	0.017755556	8				

Comparing the values of eatch method with the control group we use the *t*-test with the assumption that the values of the studied groups are equal. We apllied *t*-test for G1 – G2 , G1-G3, before and after immersion in artificial saliva. The result are reported in Tabel 4.

Table 4.

	G1 - G2 (after finishing and polishing)
t Stat	2.176626959
P(T<=t) two-tail	0.095102459
t Critical two-tail	2.776445105

	G1 - G2 (after 90 days in artificial saliva)
t Stat	2.048590079
P(T<=t) two-tail	0.00986606
t Critical two-tail	2.776445105

	G1 - G3(after finishing and polishing)
t Stat	2.274230938
P(T<=t) two-tail	0.030666744
t Critical two-tail	2.776445105

	G1 - G3 (after 90 days in artificial saliva)
t Stat	2.474396145
P(T<=t) two-tail	0.025481481
t Critical two-tail	2.776445105

Discutions

In the present study, a surface needle profilometer was used to check the roughness of the surface. It has a vertical resolution at nm, high speed, reliability, and can not damage specimens in use. Different finishing and polishing techniques determine different Ra values. Ra represents the ensemble of the micronuclearities resulting from the technological process and which are not deviating from the geometrical shape of the piece. The finishing and polish process can improve the mechanical properties of composite restorations. Composite resins have a hard component (filler) and a soft component (matrix). After finishing and polishing the filler particles are more prominent while the matrix is diminishing [6]. This mechanical process leads to the appearance of roughness, which can be decreased or increased by finishing, polish or glazing the restoration.

In our study, Group 1 (Mylar strip) had the lowest Ra values for all the composite resins tested followed by Group 3 (glaze covered restorations). After being kept for 90 days in artificial saliva, the composite specimens showed a statistically

significantly lower roughness than the first determination; This is consistent with the study by Bonato F. et al who demonstrated how the roughness decreases directly proportional with time [7].

Comparing the materials, the smallest values of roughness at both determinations were present at nanocomposite with nanofiller (Filtek Ultimate, 3M ESPE). The nanocomposite is composed of individual particles and single groups of nano-sized particles that are chemically bonded inside the matrix. The nanoclusters break at a rate similar to that of the surrounding resin matrix during abrasion, leading to a surface with fewer inperferences and higher resistance to polish [8]. Differences in roughness after finishing and polishing techniques may be ascribed to distinct patterns of particle size and their arrangement within the resin matrix [14,15]. Nanotechnology has had a beneficial effect on the integration of stable chemical particles in the matrix of composite materials. It is believed that this contributes to the low rate of wear of the materials [12, 18]. In the case of surface deterioration caused by contact with the abrasive instruments for finishing, the surface of the nanoparticles seems to suffer the least loss of minerals. This would explain the low roughness of the surface of the samples made from these materials[19]. For a composite finishing system to be rendered effective, the cutting particles must be harder than the filler particles, otherwise the abrasive medium may abrade the softer matrix and only round the filler particles. This may paradoxically result in higher surface roughness[14,16,17]. Composite surfaces should be completely contoured, finished, and polished before using surface sealing because the use of surface sealant only, will not adequately compensate for surface irregularities produced during the condensation of the composite materials in the cavities[18].

Kaminedi *et al*. concluded that immediate finishing and polishing under coolant resulted in the best surface smoothness and hardness values in microhybrid composite; however, immediate dry finishing and polishing gave the best smoothness and hardness values in nanohybrid composite.[9] Venturini *et al*. concluded that the timing and type of polishing system can affect the surface roughness of the composite.[10] Viana *et al*. observed no significant difference in roughness related to thermocycling and the type of polishing.[11] Chinwlatti *et al*. concluded that regardless of the composite resin, surface hardness was considerably increased when polishing was delayed and performed 1 week after preparation of the samples.[12] Meena Kumari *et al*. in their study found no difference in surface roughness among the tested groups when polished with shofu multistep polishing system.[13] Madhyastha *et al*. concluded from their study that smooth surface can be obtained by delaying the finishing and polishing procedures,[4] whereas Venturini *et al*. found no negative influence on the immediate polishing of restoration.

CONCLUSIONS:

The surfaces roughness of the composite resins coated with the glaze was less that on the control group. Removing the finishing and polishing steps by applying a glaze over the composite restoration significantly reduces the working time. Considering application time and achievement of a Mylar strip-like surface, the Seal-and-Shine surface sealant system should be used in anterior and posterior resin composite restorations.

REFERENCES

1. Rashmi G. Chour, Aman Moda,[1] Arpana Arora,[2] Muhmmed Y. Arafath,[3] Vikram K. Shetty,[4] and Yousef Rishal[5] **Comparative evaluation of effect of different polishing systems on surface roughness of composite resin: An *in vitro* study** J Int Soc Prev Community Dent. 2016 Aug; 6(Suppl 2): S166–S170
2. Rishi D Yadav, Deepak Raisingani, Divya Jindal,and Rachit Mathur **A Comparative Analysis of Different Finishing and Polishing Devices on Nanofilled, Microfilled, and Hybrid Composite: A Scanning Electron Microscopy and Profilometric Study** Int J Clin Pediatr Dent. 2016 Jul-Sep; 9(3): 201–208.
3. Ergücü Z, Türkün LS Oper **Surface roughness of novel resin composites polished with one-step systems**. Dent. 2007 Mar-Apr; 32(2):185-92.
4. Madhyastha PS, Naik DG, Srikant N, kotian R, Bhat KM **Effect of finishing/polishing techniques and time on surface roughness of silorane and methacrylate based restorative materials**.. Oral Health Dent Manag. 2015;14:212–8.
5. Gonçalves MA, Teixeira VC, Rodrigues SS, de Oliveira RS, Salvio LA **Evaluation of the roughness of composite resins submitted to different surface treatments.** Acta Odontol Latinoam. 2012; 25(1):89-95.
6. Abzal MS, Rathakrishnan M, Prakash V, Vivekanandhan P, Subbiya A, Sukumaran VG,**Evaluation of surface roughness of three different composite resins with three different polishing systems.** J Conserv Dent. 2016 Mar-Apr; 19(2):171-4.
7. Bonato F, Spohr AM, Mota EG, Rodrigues-Junior SA, Burnett LH Jr. **Surface roughness and maintenance of surface sealants for resin composites after toothbrushing.**, Am J Dent. 2016 Feb;29(1):39-45.
8. Attar N **The effect of finishing and polishing procedures on the surface roughness of composite resin materials.** J Contemp Dent Pract. 2007 Jan 1; 8(1):27-35.
9. Kaminedi RR, Penumatsa NV, Priya T, Baroudi K, **The influence of finishing/polishing time and cooling system on surface roughness and microhardness of two different types of composite resin restorations.** J Int Soc Prev Community Dent. 2014 Dec; 4(Suppl 2):S99-S104.
10. 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 Jan-Feb; 31(1):11-7.
11. Viana MO, Dias AA, Vedovello S, Motta RH, Rodrigues JA, Flório FM.**Evaluation of different types of polishing of composite resin surfaces after the removal of metal and ceramic brackets.** Braz Dent Sci. 2015;18:102–10**.**
12. Chinelatti MA, Chimello DT, Ramos RP, Palma-Dibb RG, **Evaluation of the surface hardness of composite resins before and after polishing at different times.,** J Appl Oral Sci. 2006 Jun; 14(3):188-92
13. Kumari CM, Bhat KM, Bansal R,**Evaluation of surface roughness of different restorative composites after polishing using atomic force microscopy.** J Conserv Dent. 2016 Jan-Feb; 19(1):56-62.
14. Ryba TM, Dun NWJ, Murchison DF.. **Surface roughness of various packable composites**. Oper Dent 2002;27:243-247.
15. Jung M, Voit S, Klime K.**Surface geometry of three packable and one hybrid composite after finishing**. Oper Dent 2003;28:53-59.
16. Nagem-Filho H, D'Azevedo MTFS, Nagem HD, Marsola FP.**Surface roughness of composite resins after finishing and polishing**. Braz Dent J 2003;14:37-41
17. Reis AF, Giannini M, Lovadino JR, Ambrosano GM.**Effects of various finishing systems on the surface roughness and staining susceptibility of packable composite resins.** Dent Mater 2003;19:12-18.
18. Roeder LB, Tate WH, Powers JM.**Effect of finishing and polishing procedures on the surface roughness of packable composites**. Oper Dent 2000; 25(6):534–543.
19. Simona Stoleriu, Gianina Iovan, Galina Pancu, Irina Nica, Sorin Andrian, **Study concerning the influence of the finishing and polishing systems on the surface state of various types of composite resins.** ,Romanian Journal of Oral Rehabilitation Vol. 5, No. 3, July - September 2013