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Evaluation of Finishing/Polishing Techniques on Low-Shrink Posterior Restorative After Mechanical Cycling

Avaliação de Técnicas de Acabamento/Polimento em Restaurações Posteriores de Baixa Contração Após Ciclagem Mecânica

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Abstract

The aim of this study was to evaluate the surface roughness of a silorane and methacrylate-based composite resins subjected to different finishing/polishing techniques. Twelve disk specimens were prepared from each composite resin: P90®, Z350® and Charisma, divided into 12 groups according to the finishing/polishing technique: no finishing/polishing (control); finishing with 1112 FF diamond burs; finishing with 1112 FF diamond burs associated to Enhance/Pogo; finishing with 1112 FF diamond burs associated to Enhance/Pogo/Polishing/Poli I and II pastes/Fotogloss. After initial readouts of surface roughness, the specimens were subjected to mechanical cycling (1.200.000 cycles) and immediately subjected to final roughness readouts. Surface roughness means was statistically analyzed by ANOVA and Tukey-Kramer test (α=0.05). SEM images were realized after finishing/polishing and after mechanical cycling. The P90 composite showed surface roughness values similar to other investigated composites. However, significant difference was observed in finishing/polishing techniques. The diamond burs group showed the highest surface roughness differing from the other composite resins ($\alpha < 0.05$). Enance/Pogo showed the lowest results, which presented no difference compared to the polishing paste group ($\alpha > 0.05$). The low-shrink posterior restorative showed similar surface roughness when compared to dimethacrylate composite resins and suitable to posterior restorations.

Keywords: Tooth. Silorane Resins. Surface Properties.

Resumo

O objetivo deste estudo foi avaliar a rugosidade superficial de resinas compostas à base silorano e metacrilato submetidas a diferentes técnicas de acabamento/polimento. Foram preparadas 12 amostras de disco de cada resina composta: P90®, Z350® e Carisma, divididas em 12 grupos de acordo com a técnica de acabamento / polimento: sem acabamento / polimento (controle); acabamento com ponta diamantada 1112 FF; acabamento com ponta diamantada 1112 FF associada a Enhance / Pogo; acabamento com ponta diamantada 1112 FF associada a Enhance / Pogo / Polishing / Pastas Poli I e II / Fotogloss. Após as leituras iniciais da rugosidade da superfície, os espécimes foram submetidos a ciclos mecânicos (1.200.000 ciclos) e submetidos imediatamente a leituras de rugosidade final. As medias de rugosidade superficial foram analisadas estatisticamente por ANOVA e teste de Tukey-Kramer (α = 0,05). As imagens de MEV foram realizadas após o acabamento / polimento e após a ciclagem mecânica. O compósito P90 mostrou valores de rugosidade superficial semelhantes a outros compósitos investigados. Tough, mostrou diferença significativa nas técnicas de acabamento / polimento. O grupo de pontas damantadas apresentou maior rugosidade superficial que diferiu das outras resinas compostas (α <0,05). Enance / Pogo mostrou os menores resultados, que não apresentaram diferença em relação ao grupo de pasta de polimento (α> 0,05). O material restaurador posterior de baixa contração apresentou rugosidade superficial semelhante quando comparado as resinas compostas de dimetacrilato e são restaurações adequadas para região posterior.

Palavras-chave: Dente. Resinas de Silorano. Propriedades de Superfície.

1 Introduction

Dimethacrylate based monomers such as Bis-GMA/TEGDMA or urethane dimethacrylate (UDMA) are commonly used as the organic matrix in most commercially available composites[1,2]. However, this organic matrix has been considered the weakest link of the widely used methacrylate-based composites due to their polymerization shrinkage that has been stated to be their main drawback, remaining a major obstacle [3]. In this sense, the Filtek P90 low-shrink Silorane-containing posterior restorative composite resin was developed to present polymerization shrinkage below 1%, which decreases the stress shrinkage[1].

The silorane composite has different resin chemistry[4], consisting of two main components, the siloxane, which is a hydrophobic part giving the stability of the material. The second part is oxirane, which is responsible for cationic polymerization reaction[5]. These composites exhibit similar or better mechanical and physical properties than the conventional methacrylate-based composites[6]. The presence of molecules of siloxanes and oxiranes offers hydrophobicity and low water sorption, resulting in reduced tendency of exogenous pigmentation, clinical longevity and similar wear strength to the dimethacrylate-based composites[1,2,7]. Another aspect regarding silorane system is that the surface of the quartz particles is modified by a silane layer[8]. This difference may influence on the surface roughness and polishing of the restorative materials[9,10].

Surface roughness and gloss are recognized among the important properties of composite resin restoration. A smooth surface improves the esthetics; reduces plaque retention capacity, surface discoloration, tissue inflammation, and secondary caries[11]; and adds comfort to the patient[12]. Although, the difference in the surface roughness of these materials may be attributed to composition, size and the area occupied by the filler particles within a composite formulation, that is capable of influencing the polishing performance [9,10].

The proper finishing and polishing of dental restoratives are critical clinical procedures and very important for the esthetics and restoration longevity[13,14]. The finishing/polishing procedures require the use of sequence ranging from the coarsest grits to the finest grits, in order to achieve a smooth and gloss surface[15]. However, different particle sizes of composites promote different surface roughness and gloss; in addition, differing polishing systems yield different results on material surfaces[16].

There are few studies in the literature that evaluate the surface smoothness of silorane composites. Thus, the purpose of this study was to evaluate roughness of the surfaces of Filtek P90 (3M ESPE) low-shrink posterior restorative compared to methacrylate-based composites: Filtek Z350 (3M ESPE) and Charisma (Heraus Kulzer), subjected to different finishing/polishing techniques.

2 Material and Methods

2.1 Specimen preparation

Three types of composite resins differing in filler chemistry and composition were used for investigation in this study (Table I). Forty-eight disc specimens (Ø: 5 mm, h: 2 mm) were prepared of each type of composite resin using a stainless steel matrix. An instrument was used on the unique increment with the purpose of providing superficial smoothness and flowing the excessive material. After that, the specimens were irradiated for 20 seconds in a distance of 3 mm with a halogen light-curing unit (Vip Curing Ligths-BISCO Dental Products IL, USA) operated at 600 mW/cm^2 irradiance and stored in artificial saliva at 37 °C for 24 hours.

Table 1 - The composition of composite resins investigated in this study

Composite resin (Shade A3)	Composition		Filler Size	Filler Content (%wt)
	Matrix	Filler		
Z350 (Nanofilled)	Bis-GMA, Bis-EMA, TEGDMA, UDMA	Zirconia/ silica (nanoclusters); Silica (nanoparticles)	Nanoclusters 0.6-1.4 µm Nanoparticle 20 nm	60
P90 (Microhybrid)	Silorane	Quartz e Ytrium fluoride	0.4 µm	58
Charisma Microhybrid)	Bis-GMA, TEGDMA	Fluor/Barium/ SilicioSilca dispersed	Ø 0.7 - 2 µm	64

Bis-GMA (bisphenol A glycidyl methacrylate); Bis-EMA (bisphenol A di-glycol ethoxylate dimethacrylate); TEGDMA (triethylene glycol dimethacrylate); UDMA (urethane dimethacrylate).

2.2 Finishing/polishing procedures

After the storage, all samples were subsequently subjected to finishing/polishing procedures divided into twelve groups (n=12) according description in Table 2.

Table 2 – The different finishing and polishing procedures performed in this study

Composite	Group	Finishing/polishing procedures
P90® Microhybrid	Group 1	Without finishing/polishing (control group)
	Group 2	Finishing with 1112 FF diamond burs
	Group 3	Finishing with 1112 FF diamond burs, Enhance and Pogo
	Group 4	Finishing with 1112 FF diamond burs, Enhance, Pogo and polishing paste Poli I,II and Fotogloss.
Z350® Nanofilled	Group 5	Without finishing/polishing (control group)
	Group 6	Finishing with 1112 FF diamond burs
	Group 7	Finishing with 1112 FF diamond burs, Enhance and Pogo
	Group 8	Finishing with 1112 FF diamond burs, Enhance, Pogo and polishing paste Poli I,II and Fotogloss.
Charisma® Microhybrid	Group 9	Without finishing/polishing (control group)
	Group 10	Finishing with 1112 FF diamond burs
	Group 11	Finishing with 1112 FF diamond burs, Enhance and Pogo
	Group 12	Finishing with 1112 FF diamond burs, Enhance, Pogo and polishing paste Poli I,II and Fotogloss.

Source: Research Data.

The polishing procedure was performed by a sole operator and according to the manufacturer's instructions. All specimens were washed and dried with syringe to remove any remaining polishing debris.

2.3 Surface Roughness Measurements Initial

The surface roughness was read with a SE 1200 surface roughness meter (Kosaka Lab, Tokyo, Japan), over 5 mm of distance and 0.8 mm cut-off at a speed of 0.25 mm/s. Four readouts were taken at different regions of the specimen surface and the mean surface roughness (Ra) was recorded.

2.4 Mechanical Cycling

After initial surface roughness measurements, the specimens were coupled to the mechanical cycling machine Erios (ER-37000, Mechanical Module) and subjected to 1.200.000 load cycles with 2 cycle/seconds to replicate an intermittent vertical load of 49 N on the restoration. During the test, the specimens were submerged in distilled water at 37°C.

2.5 Surface Roughness Measurements Final

After the mechanical cycling, a new measurement of the surface roughness was recorded to verify the effectiveness of the finishing/polishing procedures.

2.6 Statistical analysis

Three-way analysis of variance (ANOVA) was used to analyze the influence of aging, composite material and finishing/polishing techniques on surface roughness. The Tukey test was applied at a level of significance (α =0.05).

3 Results and Discussion

Three-way ANOVA showed statistically significant difference only to treatment and mechanical cycling factors. Tukey test was applied and presented in Table III, in which 1112 FF diamond burs system showed the highest roughness values (0.70 µm). Diamond Burs + Pogo + Enhance showed the lowest results (0.44 µm) which did not differ from polishing paste and control groups. However, these groups significantly differed from diamond burs group that showed a rougher surface.

In the mechanical cycling analysis, the final roughness (0.58) was higher than the initial roughness (0.53) with statistical difference.

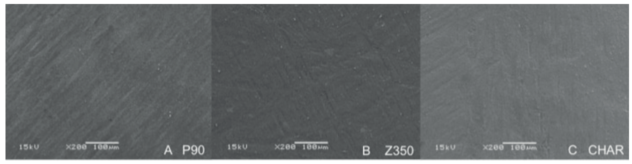
Table 3 - Mean roughness to finishing/polishing procedures of the statistical analysis by Tukey.

Material	Mean Ra (DP)
Diamond burs (DB)	0.70 (0.21) a
Without finishing polishing (C)	0.58 (0.24) b
Polishing paste (PP)	0.50 (0.21) bc
Rubberized abrasives (EP)	0.44 (0.15) c

*Difference letters indicate statistical significance difference (α <0.05).
Fonte: Research Data .

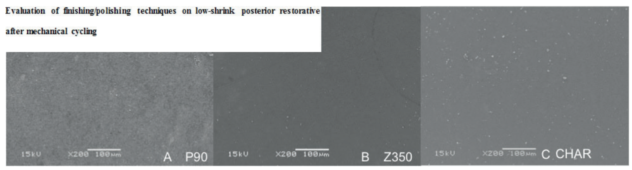
SEM examination of the specimens confirmed the roughness data. Typical SEM photomicrographs images of the specimens with the finishing with 1112 FF diamond burs created a rougher surface for all the composite resins (Figures 1A, 1B and 1C). More homogeneous and smooth surfaces were observed after finishing/polishing procedures of the polishing paste groups (Figures 2 A, B and C) and rubberized abrasives (Figures 3 A, B and C).

Figures 1 - SEM photomicrographs images specimens of P90 (A), Z350 (B) and Charisma (C) composites resin finishing with diamond burs.



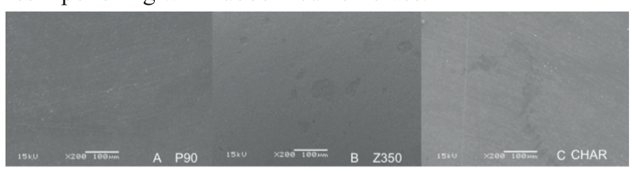
Source: The authors .

Figures 2 - SEM image (200X) specimens of P90 (A), Z350 (B) and Charisma (C) composite resin polishing with polishing paste.



Source: The authors .

Figures 3 - Photomicrographs (200X) of the specimens prepared with P90 (A), Z350 (B) and Charisma (C) composite resin polishing with rubberized abrasives.



Source: The authors.

The main target of any esthetic restorative material is to have a durable restoration that can withstand function as well as a highly finished and polished surface that may contribute to a good appearance[4]. The composites of this study were selected because they represent different formulations of restorative materials with properties to be used as restorers for posterior teeth.

The results of this study showed that the restorative materials presented the same surface roughness pattern regardless of polishing system and mechanical cycling. The surface of the composite containing smaller filler particles, usually have more wear resistant showing more homogeneous [14]. These smaller particles can be worn rather than plucking, resulting in less friction and abrasion of the composite providing sufficiently smooth surfaces. Although the varied type of the investigated materials in this study and the most important difference between silorane-based and methacrylate-based composite resins relates to the organic matrix of these composites, with regard to filler content, silorane composites contain fine particulate quartz fillers below 0.5 µm in size[17].

This explains their similar smooth surface after finishing/polishing of the restoration in comparison with conventional composites. Thus, all composite resins used in this study contains, on average, particles of 0.4 µm, and no significant differences were observed in surface roughness, this statement was confirmed in the present study.

The highest values of surface roughness were observed in the groups with the 1112 FF diamond burs finish (DB), which showed significant difference when compared to the other groups. Due to the fact that in posterior restorations are unviable the use of polyester matrix since it is necessary to obtain a correct anatomical shape and contour of the occlusal surfaces of posterior tooth, the specimens were prepared without the use of the matrix. So in the control group, the finish of the composite resin was made only with instruments. For the accomplishment of finishing and polishing procedures on posterior teeth it is necessary to make use of diamond burs, in order to obtain a correct anatomy and contour to the shape of the occlusal surfaces of posterior teeth [18] and proximal contacts. The use of only finishing diamond burs creates roughened surfaces with the use of these polishing paste does not provide the same level of smoothness observed when using abrasive or aluminum oxide discs[19]. The fact that the control group, without finishing, presented less roughness values than the finishing group with the 1112 FF diamond burs (P), which may have its explanation based on the study of Maresca et al.[19], that evaluated the effect of the use of different finishing instruments on the marginal integrity. The authors identified that the negative control, which consisted of surface composites polished with a regular diamond burs produced the largest marginal gaps. Interestingly, coarse finishing instruments may also have a negative effect on the restoration surface. Supposedly, the surfaces of specimens finished with diamond burs may have resulted in fissures or cracks onthe surface of the composite resin.

The mechanical cycling has been studied due to their potential capacity to mimic the natural aging of the restorations due the masticatory movements simulations[20,21]. As the results of this study, several studies suggest that mechanical cycles can accelerate the deterioration of restoration[20]. The forces below the limit of proportionality after several times can dramatically affect the structure of the composite resin and cause micro-cracks. Moreover, there is a possibility of breaking the union of filler/silane and consequently displacement of the particles causing irregularities on the surface[22,23].

Data revealed that the rubberized abrasives points (Enhance and Pogo) as well as the same groups of polishing paste produced similar surface smoothness for all the composites. The property of surface roughness of any material is the result of the interaction of multiple factors. Some of these factors are associated with the type of polishing system used, such as the flexibility which abrasive material is embedded, hardness, shape, and grit of the abrasive components and the instrument geometry. All the tested specimens were subjected o the same parameters of finishing/polishing procedures. The procedures were kept to a total time of 30 seconds and 10 seconds for each step performed by a sole operator, in order to ensure a uniform polishing, the surface roughness probably was dependent on the abrasive, which showed a roughness texture similar for all tested composites.

4 Conclusion

Within the limitations of this *in vitro* study, the following conclusions can be draw:

The exclusive use of diamond burs to finishing/polishing procedures for composite resin resulted in a rough surface.

The low-shrink posterior restorative showed similar results when compared with dimethacrylate composite resins.

Clinical Siginificance: Silorane dental composite can be indicated to posterior restorations.

Reference

1. Marques IP, de Oliveira FBS, Souza JGS, Ferreira RC, Magalhães CS, França FMG, et al. Influence of surface treatment on the performance of silorane-based composite resin in class I restorations: a randomized clinical trial. Clin Oral Investig 2018;11(4):222-8 doi: 10.1007/s00784-018-2390-5.
2. Terry DA, Leinfelder KF, Blatz MB. A comparison of advanced resin monomer technologies. Dent Today 2009;28(7):122-3.
3. Goldberg M. In vitro and in vivo studies on the toxicity of dental resin components: a review. Clin Oral Investig. 2008;12(1):1-8.
4. Marghalani HY. Effect of finishing/polishing systems on the surface roughness of novel posterior composites. J Esthet Restor Dent 2010;22(2):127-38.
5. Eick JD, Kotha SP, Chappelow CC, Kilway KV, Giese GJ, Glaros AGet al. Properties of silorane-based dental resins and composites containing a stressreducing monomer. Dent Mater 2007;23(8):1011-7.
6. Lien W, Vandewalle KS. Physical properties of a new silorane-based restorative system. Dent Mater 2010;26(4):337-44.
7. Eick JD, Smith RE, Pinzino CS, Kostoryz EL. Stability of silorane dental monomers in aqueous systems. J Dent 2006;34(6):405-10.
8. Bechtold J, Santos PJ, Anido-Anido A, Di Hipólito V, RCB Alonso, D'Alpino PHP. Hardness, polymerization depth, and internal adaptation of Class II silorane composite restorations as a function of polymerization protocol. Eur J Dent 2012;6(2):133-40.
9. Tanoue N, Matsumura H, Atsuta M. Wear and surface roughness of current prosthetic composites after toothbrush/dentifrice abrasion. J Prosthet Dent 2000l;84(1):93-7.
10. Sarac D, Sarac YS, Kulunk S, Ural C, Kulunk T. The effect of polishing techniques on the surface roughness and color change of composite resins. J Prosthet Dent 2006;96(1):33-40.
11. Scheibe KGBA, Almeida KGB, Medeiros IS, Costa JF, Alves

CMC. Effect of different polishing systems on the surface roughness of microhybrid composites. J Appl Oral Scie 2009;17(1):21-6.

12. Bashetty K, Joshi S. The effect of one-step and multi-step polishing systems on surface texture of two different resin composites. J Cons Dent 2010;13(1):34-8.
13. 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.
14. Ereifej NS, Oweis yg, Eliades G. The effect of polishing technique on 3-D surface roughness and gloss of dental restorative resin composites. Oper Dent 2013;38(1):1-12.
15. Setcos JC, Tarim B, Susuki S. Surface finish produced on resin composites by new polishing systems. Quint Int 1999;30(3):169-73.
16. Da Costa J, Ferracane J, Paravina R, Mazur R, Roeder L. The effect of different polishing systems on surface roughness and gloss of various resin composites. J Esthet and Restor Dent 2002;19(4):214-26.
17. Mourouzis P, Koulaouzidou EA, Vassiliadis L, Helvatjoglu-Antoniades M. Effects of sonic scaling on the surface roughness of restorative materials. J Oral Sci 2009;51(4):607-14.
18. Gedik R, Hürmüzlü F, Coşkun A, Bektaş OO, Ozdemir AK. Surface roughness of new microhybrid resin-based composites. J Am Dent Assoc 2005;136(8):1106-12.
19. Maresca C, Pimenta LA, Heymann HO, Ziemiecki TL, Ritter AV. Effect of finishing instrumentation on the marginal integrity of resin-based composite restorations. J Esthet Restor Dent 2010;22(2):104-12.
20. Bedran-de-Castro AK, Pereira PN, Pimenta LA, Thompson JY. Effect of thermal and mechanical load cycling on microtensile bond strength of a total-etch adhesive system. Oper Dent 2004;29(2):150-6.
21. Mitsui FH, Peris AR, Cavalcanti AN, Marchi GM, Pimenta LA. Influence of thermal and mechanical load cycling on microtensile bond strengths of total and self-etching adhesive systems. Oper Dent 2006;31(2):240-7.
22. Madhyastha PS, Hegde S, Srikant N, Kotian R, Iver SS. Effect of finishing/polishing techniques and time on surface roughness of esthetic restorative materials. Dent Res J 2017;14(5):326-30.
23. Abed Kahnamouei M, Gholizadeh S, Rikhtegaran S, Daneshpooy M, Kimyai S, Alizadeh Oskoee P, et al. Effect of preheat repetition on color stability of methacrylate-and silorane-based composite resins. J Dent Res Dent Clin Dent Prospects 2017;11(4):222-8. doi: 10.15171/joddd.2017.039.