The difference between one-step polishing systems on surface roughness, microhardness, and color stability of bulk-fill composite resin

Regia Aristiyanto, Almira Rahmanita**, Galih Hanur Cahyo**, Septa Intan Lastanta***

**Department of Conservative Dentistry, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta*

***School of Dentistry, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta*

Correspondence: regia@umy.ac.id

Received 15 September 2022; 1st revision 7 March 2023; 2nd revision 10 July 2023; Accepted 11 July 2023; Published online 31 July 2023

Keywords:

Bulk-fill composite resin; surface roughness; microhardness; color stability; one-step polishing system

ABSTRACT

Background: *The polishing procedure was an important step in composite resin restoration as it reduces restoration surface roughness. Smooth and well-polished restoration surfaces can increase microhardness and minimize discoloration on the tooth surface. The study aims to examine the differences of one-step polishing systems on surface roughness, microhardness, and color stability of bulk-fill composite resin.*

Method: *The samples were bulk-fill composite resin moulded with 4 mm of diameter and thickness (n=30) for microhardness (n=15) and surface roughness (n=15) test and moulded with 6 mm of diameter and 4 mm of thickness for color stability (n=15) test. The samples were divided into three groups consisting of 5 samples for each variable and were polished using PoGo, OptraPol, and OneGloss. Color stability test samples were immersed in tea solution for 7 days. Color stability measurement was done by comparing the results of color measurements using a spectrophotometer before and after immersion. Microhardness was tested using Vickers Microhardness Tester, while surface roughness was tested using the Stylus Profilometer Fowler Surfcorder SE1700.*

Result: *The data analysis showed that PoGo produced the smoothest surface roughness significantly (p=0.006), the highest microhardness significantly (p=0.002), and the lowest color change significantly (p = 0.027)*

Conclusion: *PoGo produced lowest surface roughness and color change, and highest microhardness compare with OptraPol and OneGloss.*

doi: http://dx.doi.org/10.30659/odj.10.1.69-75
2460-4119 / 2354-5992 ©2022 National Research and Innovation Agency

Odonto : Dental Journal accredited as Sinta 2 Journal (https://sinta.kemdikbud.go.id/journals/profile/3200)
How to Cite: Aristiyanto *et al*. The difference between one-step polishing systems on surface roughness, microhardness, and color stability of bulk-fill composite resin. Odonto: Dental Journal, v.10, n.1, p. 69-75, July 2023.

INTRODUCTION

Composite resin is the most widely used dental restorative material due to its color, good durability, and its ability to be manipulated.[1–4] However, the composite resin has a weakness, including polymerization shrinkage. Polymerization shrinkage is a contraction that occurs in the composite resin during the polymerization process, causing a marginal gap between the composite resin and the tooth structure. The marginal gap can cause secondary caries, staining, fracture of the cusp, and post-restorative pain.[5] One technique to reduce polymerization shrinkage is the incremental technique.[6]

The incremental technique is a technique for applying composite resins in layers.[6] This technique's weakness includes prolonged clinical procedure and the risk of forming voids between layers.[7] Bulk fill composite resin is developed to overcome the shortcomings of conventional composite resin. Bulk fill composite resin can be applied into a cavity up to 4 mm in one application.[5]

The polishing procedures provide a smooth and glossy restoration surface, and affect the marginal bond of the composite resin.[8,9] The use of a polishing instrument can reduce surface roughness, minimize tooth discoloration, and increase microhardness.[10–13] Like conventional composites, the importance of polishing procedure was also in bulk-fill composite resin because the roughness and irregular surface lead to plaque accumulation, gingival inflammation, superficial staining, and secondary caries.[14]

The polishing instrument can be carbide bur, diamond point, abrasive disc, abrasive finishing strips, and polishing pastes. There are two types of polishing tools, the multi-step polishing system and the one-step polishing system. The multi-step polishing system is a polishing instrument with various roughness levels, while the one-step polishing system has only one polishing tool.[15] PoGo, OptraPol, and OneGloss are one-step polishing systems. This study aims to examine the differences between various one-step polishing tools on surface roughness, microhardness, and color stability of bulk-fill composite resins.

RESEARCH METHOD

Specimens

The specimens were bulk-fill composite resin molded with a diameter of 6 mm and a thickness of 4 mm for the color test (n=15), as well as a diameter of 4 mm and a thickness of 4 mm for the microhardness test (n =15) and surface roughness (n=15). The microscope glass slide was placed on the top and the bottom of the surfaces of the mold to get a flat surface. Five hundred grams of scales were placed for 10 seconds on the top of the microscope glass slide to make bulk-fill composite resin evenly distributed throughout the mold. The specimens were polymerized with a light cure of Light Emitting Diode (LED) (Woodpecker LED B, Zhengzhou, China) for 20 seconds at a light intensity of 850 mW/cm^2. All specimens were roughened with sandpaper number 1200 for 5 seconds, and then the specimens were divided into three groups (surface roughness, microhardness, and color stability measurement). Each group was subdivided into three subgroups, each of which had 5 specimens, according to the type of polishing system as follows:

- Subgroup 1: The specimens were polished with a PoGo (Dentsply Sirona, Milford, USA) polishing system.
- Subgroup 2: The specimens were polished with an OptraPol (Ivoclar Vivadent, Schaan, Liechtenstein) polishing system.
- Subgroup 3: The specimens were polished with an OneGloss (Shofu Inc, Kyoto, Japan) polishing system.

Each group was polished with an intermittent technique for 15 seconds at a speed of 15.000 rpm. Furthermore, all specimens were immersed in distilled water and were incubated for 24 hours at 37°C.

Surface Roughness

Surface roughness was avowed by roughness average (Ra) in micrometers. Ra shows the arithmetic mean of the roughness measurement for a certain surface length. All specimens from the surface roughness group were measured using the Stylus Profilometer SE1700. The higher Ra value indicate the rougher bulk-fill composite resin surface. Data were analyzed by one-way ANOVA test and Least Significant Difference test.

Microhardness

Microhardness was avowed in units of Hardness Vickers Number (HVN). All specimens from the microhardness group were tested using the Vickers Microhardness Tester (HMV-M3). The hardness test was carried out on the surface with a load of 100 grams for 20 seconds. The average value of microhardness was obtained from three tests on each specimen. Data were analyzed by the Kruskal Wallis test and Mann-Whitney test.

Color Stability

The color stability test was performed before and after immersion with tea solution. Immersion was held for 7 days. Specimens were rinsed with water and dried with a tissue before testing. All specimens from the color stability group were tested using a spectrophotometer (Shimadzu Japan UV-2401-PC ISR-2200). The measurement of color change in bulk fill composite resin was calculated for its chromaticity value using the formula E (L*a*b*). Data were analyzed using the Kruskal Wallis test and Mann-Whitney test.

RESULTS

Table 1 and Figure 1 shows the surface roughness values of three subgroups from the surface roughness group. The specimens were polished using PoGo and exhibited the lowest average surface roughness value compared to Optrapol and OneGloss (Table 1). One-way ANOVA analysis (Table 2) showed a significant difference between the three groups ($p=0.006$). The Least Significant Difference test (Table 3) showed that PoGo had a significant difference in the average surface roughness value compared to the OptraPol and OneGloss with a significance value of $p<0.05$.

Table 1. Surface roughness, microhardness, and color change value

	Surface Roughness (Ra)		
	Pogo	Optrapol	OneGloss
Mean	1.19	2.03	1.70
SD	0.25	0.48	0.21
	Microhardness (HVN)		
	Pogo	Optrapol	OneGloss
Mean	56.08	43.56	51.18
SD	1.27	1.26	1.02
	Color Change		
	Pogo	Optrapol	OneGloss
Mean (before)	1.24	1.54	1.34
SD	0.77	0.98	0.300
Mean (after)	3.04	4.55	4.21
SD	1.00	0.20	0.98

SD=Standard deviation

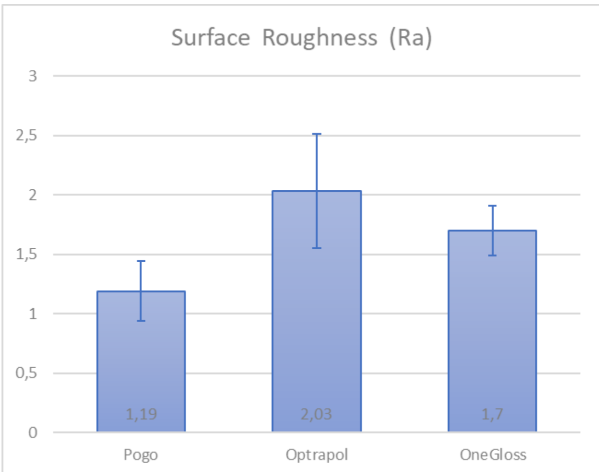

Figure 1. Mean and standar deviation value of surface roughness

Table 2. One-way ANOVA test

F	df1	df2	Sig.
7.963	2	12	0.006

Table 3. Least Significant Difference test

Subgroup		Average Different	Sig.
Pogo	Optrapol	-.842400	.002*
	OneGloss	-.513200	.033*
Optrapol	Pogo	.842400	.002*
	OneGlos	.329200	.148
OneGloss	Pogo	. 513200	.033*
	Optrapol	-.329200	.148

* Significant

The microhardness values are shown in table 1 and Figure 2. The PoGo had the highest average value of microhardness (56.08 HVN), followed by OneGloss (51.18 HVN) and OptraPol (43.56 HVN). Kruskal Wallis test (Table 4) denoted differences in microhardness between groups (p=0.002). The Mann-Whitney test showed a significant difference (p=0.009) between PoGo, the OptraPol and, OneGloss (Table 5).

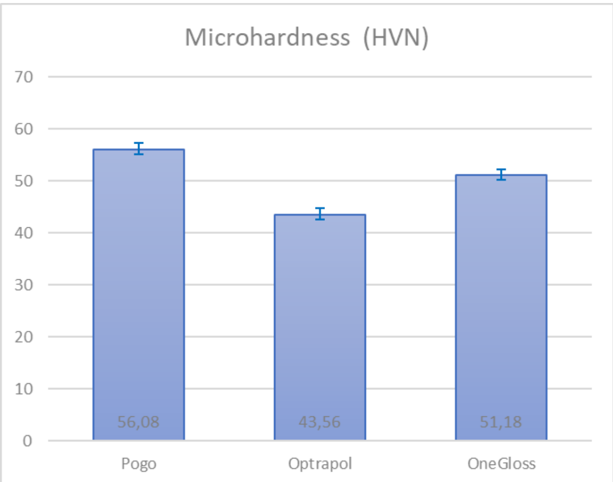

Figure 2. Mean and standar deviation value of microhardness

Table 4. Kruskal Wallis test

Test Statistic^{a,b}	
	Microhardness
Kruskal-Wallis H	12.545
df	2
Asymp. Sig.	.002

Table 5. Mann-Whitney test

Polishing System	OneGloss	Optrapol	Pogo
OneGloss	-	.009*	.009*
Optrapol	.009*	-	.009*
PoGo	.009*	.009*	-

* Significant

Table 1 and Figure 3 shows the average of color change value of bulk-fill composite resin. PoGo exhibited the lowest color change (1.24 before immersion and 3.04 on the 7th day of immersion) compared to the Optrapol (1.54 before immersion and 4.55 on the 7th day of immersion) and OneGloss (1.34 before immersion and 4.21 on the 7th day of immersion). Kruskal-Wallis test (Table 6) pointed out a significant difference in color change between groups (p=0.027). The Mann-Whitney test (Table 7) showed that PoGo had a significant difference compared to OptraPol (p=0.009) and was not significant compared to OneGloss (p=0.175).

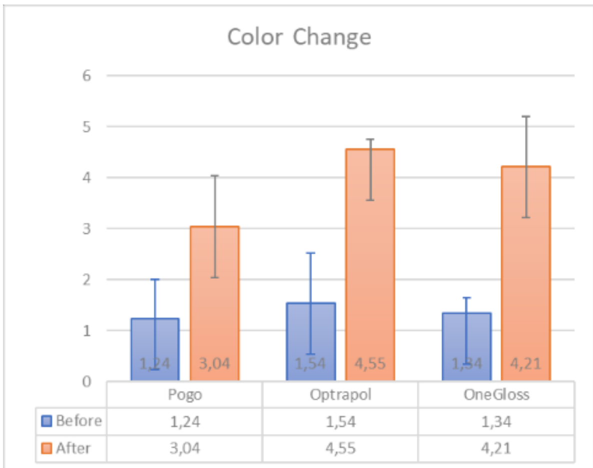

Figure 3. Mean and standar deviation value of color change

Table 6. Kruskal Wallis test

Test Statistics^{a,b}		
	Day-0	Day-7
Ch-square	0.215	7.220
df	2	2
Asymp. Sig.	.898	0.027

Table 7. Mann-Whitney test

Polishing System	OneGloss	Optrapol	Pogo
OneGloss	-	.175	.175
Optrapol	.175	-	.009*
PoGo	.175	.009*	-

* Significant

DISCUSSION

Restoration surface quality is one of the important factors in long-lasting restoration using composite resin. The rough surface of composite resin restorations due to poor polishing causes staining, plaque adhesion, gum irritation and secondary caries.[8] A rough surface also decreases mechanical properties and increases wear on restoration.[16]

The polishing procedure can reduce the surface roughness of the composite resin.[17] Roughness increases of more than 0.3 mm cause more stain absorption compared to surfaces with low roughness values.[18] The rough surface of the restoration causes the staining material to adhere to the surface of composite resin easily. Surface roughness is also critical to composite resin restoration in the subgingival margin because related to periodontal disease development and hygiene is difficult.[19]

Regarding the microhardness, the polishing procedure may increase the microhardness of composite resin.[17] Microhardness is a composite resin property related to the resistance of composite resin to masticatory forces and affects the durability of the composite resin.[20] Restoration surfaces with good hardness and resistance to wear are obtained by proper polishing procedures to remove the superficial layer composed of an organic matrix softer than the inner layer.[21]

The polishing procedure also affects the discoloration of composite resin restoration.[22] A high degree of smoothness and low porosity on the restoration surface reduces the attachment of the discoloring agent.[23] Schmitt et al. stated that the low surface roughness value after polishing had the great color resistance.[24]

The results showed that specimens polished using Pogo had the lowest surface roughness (p=0.006) and the highest microhardness (p=0.002) and color stability (p=0.027) compared to Optrapol and OneGloss. The abrasive particles' hardness in a polishing system affected the effectiveness of the polishing system. Abrasive particles with higher hardness than composite resin filler possible to remove the soft matrix and filler appeared on the surface of the composite resin restoration, while the abrasive particles with a lower hardness than the composite resin filler only removed the soft matrix and left a filler on the surface. It can cause the surface of the composite resin restoration to be rough.[11,25] Lins et al. also stated that a polishing system with abrasive particles harder than composite resin fillers was more effective in removing the organic matrix layer and resulted in a harder surface.[26]

The PoGo contained fine diamond powder of abrasive particles in its composition, while the OptraPol and OneGloss had aluminium oxide as the abrasive particle.[27] Patel et al. stated that diamond powder of abrasive particles in PoGo had a Knoop Hardness of 7000 KHN, while aluminium oxide abrasive particles in OneGloss and OptraPol hadve a Knoop Hardness of 2100 KHN.[25] Based on Moh's hardness scale, the diamond particle has the highest hardness value (10), aluminium oxide has a hardness of 9, and composite resin has a hardness of 5-7 [18]. The fine diamond powder of abrasive particles in PoGo was more effective in removing the superficial layer of bulk-fill composite resin restorations containing organic matrix as they had a higher hardness than the aluminium oxide abrasive particles in OptraPol and OneGloss.

CONCLUSION

There were significant differences in surface roughness, microhardness, and color stability in bulk- fill composite resins polished with PoGo, OptraPol and One Gloss polishing system. Bulk fill composite resin polished using PoGo had a low surface roughness and discoloration change and had a higher microhardness value than bulk-fill composite resin polished using OptraPol and OneGloss.

ACKNOWLEDGEMENT

The authors would like to thank the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, for their generous donation of materials and laboratory fees for this study.

REFERENCES

1. Craig RG, Powers JM. Restorative Dental Materials. 11th ed. St. Louis: Mosby; 2002.
2. Triwardhani L, Mozartha M, Trisnawaty. Klinis Restorasi Resin Komposit Pada Kavitas Klas I Pasca Penumpatan Tiga Tahun. Cakradonya Dent J. 2014;6(2):678–744.
3. Nurhapsari A. Perbandingan Kebocoran Tepi antara Restorasi Resin Komposit Tipe Bulk-Fill dan Tipe Packable dengan Penggunaan Sistem Adhesif Total Etch dan Self Etch. Odonto Dent J. 2016;3(1):8.
4. Puspita S, Aziz RY, Nugroho DA. Microhardness Differences between Silk Fiber As a Natural Filler Composite Resin with Nanofiller Composite Resin. Odonto Dent J. 2020;7(2):104–10.
5. Chesterman J, Jowett A, Gallacher A, Nixon P. Bulk-Fill Resin-Based Composite Restorative Materials: A Review. Br Dent J. 2017;222(5):337–44.
6. Wilson NH. Principles and Practice of Esthetic Dentistry. 1st ed. Wilson NH, editor. Elsevier Ltd; 2015. 272 p.
7. Lovan G, Stoleriu S, Moldovanu A, Morogai S, Andrian S. SEM Study of Interface between The Cavity Wall and Composite Resin in Cavities Filled Using Vibration. Int J Med Dent. 2011;(1):254–8.
8. Kaminedi R, Penumatsa N, 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;4(5):S99–104.
9. Dhurohmah, Mujayanto R, Chumaeroh S. Pengaruh Waktu Polishing dan Asam Sitrat Terhadap Microleakage pada Tumpatan Resin Komposit Nanofiller Aktivasi Light Emiting Diode - In Vitro. Odonto Dent J. 2014;1(1):11–5.
10. Oliveira ALBM, Domingos PA dos S, Campos JADB, Botta AC, Garcia PPNS. Color Stability of a Nanofilled Resin: Influence of Polishing and Finishing and Fluoride Solutions According To Time. J Res Dent. 2014;2(2):119.
11. Rigo L, Bordin D, Fardin V, Coelho P, Bromage T, Reis A, et al. Influence of Polishing System on the Surface Roughness of Flowable and Regular-Viscosity Bulk Fill Composites. Int J Periodontics Restorative Dent. 2018;38(4):e79–86.
12. Beltrami R, Ceci M, De Pani G, Vialba L, Federico R, Poggio C, et al. Effect of Different Surface Finishing/Polishing Procedures on Color Stability of Esthetic Restorative Materials: A Spectrophotometric Evaluation. Eur J Dent. 2018;12(1):49–56.
13. Ehrmann E, Medioni E, Brulat-bouchard N. Finishing and Polishing Effects of Multiblade Burs on The Surface Texture of 5 Resin Composites: Microhardness and Roughness Testing. Restor Dent Endod. 2019;44(1):1–12.
14. Van Ende A, De Munck J, Lise DP, Van Meerbeek B. Bulk-Fill Composites: A Review of the Current Literature. J Adhes Dent [Internet]. 2017;19(2):95–110. Available from: http://jad.quintessenz.de/c3b6/jad_2017_02_s0095.pdf%0Ahttp://www.ncbi.nlm.nih.gov/pubmed/28443833
15. Erdemir U, Sancakli HS, Yildiz E. The Effect of One-step and Multi-step Polishing Systems on The Surface Roughness and Microhardness of Novel Resin Composites. Eur J Dent. 2012;6(2):198–205.
16. Ningsih DS, Diansari V, Widyarti M. Pengaruh Teknik Pemolesan Satu Langkah dan Beberapa Langkah terhadap Kekasaran Permukaan Resin Komposit Nanofiller. J Mater Kedokt Gigi. 2012;1(2):100–5.
17. Münchow EA, Correa MB, Ogliari FA, Piva E, Zanchi CH. Correlation Between Surface Roughness and Microhardness of Experimental Composites with Varying Filler Concentration. J Contemp Dent Pract. 2012;13(3):299–304.
18. Jefferies SR. Abrasive Finishing and Polishing in Restorative Dentistry: A State-of-the-Art Review. Dent Clin North Am. 2007;51(2):379–97.
19. Park JW, An JS, Lim WH, Lim BS, Ahn SJ. Microbial Changes in Biofilms on Composite

Resins with Different Surface Roughness: An In Vitro Study with A Multispecies Biofilm Model. J Prosthet Dent [Internet]. 2019;122(5):493.e1-493.e8. Available from: https://doi.org/10.1016/j.prosdent.2019.08.009
20. Alfawaz Y. Impact of Polishing Systems on the Surface Roughness and Microhardness of Nanocomposites. J Contemp Dent Pract. 2017;18(8):647–51.
21. 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;14(3):188–92.
22. Gönülol N, Yilmaz F. The Effects of Finishing and Polishing Techniques on Surface Roughness and Color Stability of Nanocomposites. J Dent. 2012;40(SUPPL.2):64–70.
23. Sirin Karaarslan E, Bulbul M, Yildiz E, Secilmis A, Sari F, Usumez A. Effects of Different Polishing Methods on Color Stability of Resin Composites After Accelerated Aging. Dent Mater J. 2013;32(1):58–67.
24. Schmitt VL, Puppin-Rontani RM, Naufel FS, Nahsan FPS, Alexandre Coelho Sinhoreti M, Baseggio W. Effect of the Polishing Procedures on Color Stability and Surface Roughness of Composite Resins. ISRN Dent. 2011;2011:1–6.
25. Patel B, Chhabra N, Jain D. Effect of Different Polishing Systems on The Surface Roughness of Nano-hybrid Composites. J Conserv Dent. 2016;19(1):37–40.
26. Lins FCR, Ferreira RC, Silveira RR, Pereira CNB, Moreira AN, Magalhães CS. Surface Roughness, Microhardness, and Microleakage of a Silorane-Based Composite Resin after Immediate or Delayed Finishing/Polishing. Int J Dent. 2016;2016.
27. Ergücü Z, Türkün LS. Surface Roughness of Novel Resin Composites Polished with One-step Systems. Oper Dent. 2007;32(2):185–92.