Acta Scientific Dental Sciences (ISSN: 2581-4893)

Volume 7 Issue 4 April 2023

Research Article

Does the Difference in Finishing Systems and Time affect the Surface Roughness of Two Resin Composites? Comparison between Bulk fill and Nano resin composite

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DOI: 10.31080/ASDS.2023.07.1608

Received: February 28, 2023

Published: March 24, 2023

Abstract

Aim: evaluation of the effect of different finishing and polishing systems and the time of finishing either immediate or delayed after 24 hours on the surface roughness of bulk fill resin composite and Nano fill resin composite.

Materials and Methods: two resin composite materials were used Filtek Bulk fill resin composite and Filtek z350 Nano fill resin composite. A total of 70 resin composite specimens were prepared according to manufacturer's instructions in specially constructed split Teflon moulds of 6 mm diameter and 2 mm thickness, specimens were divided into two main groups of 35 specimens of each composite resin, 5 specimens of each group were cured under mylar strip without any finishing or polishing procedures to serve as control group, the other 30 specimen of each composite resin was divided into 3 sub-groups of 10 specimens according to type of finishing and polishing system; one step, two steps or multiple steps, then every sub group was divided into 2 groups of 5 specimens each one according to time of finishing immediate after 10 minutes and delayed after 24 hours, each of specimens was assessed for roughness measurement by optical profilometry.

Results: In each composite group, the control had the lowest Ra.

Conclusion: Nano filled resin composite exhibited smoother surface than Bulk fill resin composite irrespective of the finishing technique used or time of finishing. Mylar strip created the smoothest surface in both materials

Keywords: Time; Surface Roughness; Resin Composites; Bulk Fill

Introduction

Nano-filled composites were used for providing less polymerization shrinkage and higher resistance to traction, compression and fracture as well as an improvement in optical properties, lower attrition, and greater retention of gloss, [1]. They present similar mechanical and physical properties to those of micro-hybrid composites, but when it comes to polish and gloss retention, they perform better.

Nowadays, Bulk-fill composite advanced technology allows for directly placed posterior restorations with bulk fill resin bonded composite in a single increment can achieve high marginal adaptation to the floor and walls of cavity preparations. The bulk composite retains its shape and is manufactured with a polymerization booster for fast curing of up to 4 mm in 10 seconds in single increment. Finishing refers to the contouring, shaping, and smoothing of the restoration to give anatomical contours and to remove excess material at the interface. Polishing is a step performed after finishing when the surface gains a high luster and enamel-like texture, [2]. In this way, it is important to evaluate the effect of different polishing systems on different composite resin, concerning the surface roughness of composite resin and color maintenance on time.

Materials and Methods

Two different tooth-Coloured restorative materials were used in the study table 1: A Bulk fill resin-based composite (3M™ ESPE™ Filtek™ Bulk Fill) and Nano fill resin-based composite (3M™ ESPE™ Filtek™ Z350 XT) (Table 1). All materials were of A2 shades.

Material	Specification	Composition	Manufacturer	Lot #
Filtek™ Bulk Fill	Bulk fill Resin composite	The resin matrix is: AUDMA, UDMA and 1, 12-dodecane-DMA The fillers are: a combination of a non-agglomerated/non-aggregated 20 nm silica filler, a non-agglomerated/non-aggregated 4 to 11 nm zirconia filler, an aggregated zirconia/silica cluster filler (comprised of 20 nm silica and 4 to 11 nm zirconia particles) and an ytterbium trifluoride filler consisting of agglomerate 100 nm particles The inorganic filler loading is about 76.5% by weight (58.4% by volume).	3M ESPE, St. Paul, USA	N682081
Filtek™ Z350 XT	Universal resin composite	The resin matrix is: bisGMA, UDMA, TEGDMA, PEGDMA and bis-EMA (6) The fillers are: a combination of a non-agglomerated/non-aggregated 20 nm silica filler, a non-agglomerated/non-aggregated 4 to 11 nm zirconia filler, an aggregated zirconia/silica cluster filler (comprised of 20 nm silica and 4 to 11 nm zirconia particles) average cluster particle size of 0.6 to 10 microns. The inorganic filler loading is about78.5% by weight (63.3% by volume)	3M ESPE, St. Paul, USA	N663673

Table 1: Materials` specifications, composition, manufactures, and lot numbers.

A Teflon mold (6-mm in diameter and 2-mm thick) was used to prepare 35 specimens from each restorative material. To prepare each specimen, the mold was placed on a Mylar strip covered glass slide and the uncured resin composites were placed in the molds. Another Mylar strip was then placed over the mold and the material was compressed with a glass slide, thus extruding the excess resin composite and forming a flat surface. The samples were polymerized from the top of the mold with LED Light curing device (3M ESPE Elipar™ S10 LED, USA) according to the manufacturer's recommended polymerization times.

System	Description	Method	Lot #, Manufacturer
Control Mylar strips	4" x 3/8" (10cm x 1cm)/.002 Thick mylar transparent celluloid strip	Curing under mylar strip without any finishing	519413 Crosstex international Inc. NY, USA
Pre-finishing Diamond burs	Friction Grip - Conical with Domed End - 14mm width 20-30 µm extra Fine for Prefinishing of composites	Under water cooling spray in one direction for 15 sec	575153 Jota Diamond 852EF.FG.014 SWITZERLAND
Multiple steps Opti-discs	Polyester discs impregnated with aluminum oxide particles Coarse/medium red disc: 40um Fine orangedisc:20um Extra-fine yellow :10um	3 discs only coarse fine extra fine	4188 KerrHawe SA, SWITZERLAND
Two steps Soflex spiral	Wheels are made of thermoplastic silicone elastomer impregnated with aluminum oxide particles (25-29_um)	Soflex beige for finishing Soflex white for polishing	N527825 3M ESPE, St. Paul, USA
One step	Pure Diamond powder impregnated silicone rubber discs	Heavy pressure for finishing light pressure for polishing	10612 ITENA CLINICAL, Paris, FRANCE

Table 2: Finishing systems used in the study.

A control group of 5 specimens of each material received no finishing and polishing procedures after being cured under Mylar strip. The remaining 30 specimens from each restorative material were randomly divided into three subgroups (n = 10/group) according to the finishing/polishing system used one-step system (ITENA Perfect Polish discs, France), two-step system (3M Soflex spiral wheels, USA) and multiple-step system (KerrHawe OptiDiscs SWITZERLAND). five specimens from each finishing and polishing system sub group were finished and polished immediately after the polymerization; the other 5 were finished and polished Following storage in distilled water for 24h at 37°C., finishing procedures were done in Teflon mould of 1mm thickness to expose 1ml of the restoration to be finished

Results

Mean surface-roughness values (Ra, μm), standard deviations (± SD), and statistical analysis of the control and polished resin composites were done. When comparing mean and SD values the significance level was set at $P < 0.05$**.** Results are represented in figures 1-7.

According to changing time of finishing and polishing procedures:

Filtek z350 Nano filled resin composite:

- **One step system (Itena perfect polish discs):** When immediately used it showed 0.253 ± 0.003 statistically insignificant (P = 0.799) decrease in surface roughness compared to delayed finishing and polishing after 24 hours 0.253 ± 0.001.
- **Two step system (3M soflex spiral wheels):** When immediately used it showed 0.256 ± 0.002 statistically insignificant (P = 0.129) decrease in surface roughness compared to delayed finishing and polishing after 24 hours 0.257 ± 0.003.
- **Multiple steps system (Kerr OptiDiscs):** When immediately used it showed 0.253 ± 0.003 statistically significant decrease (P = 0.000) compared to delayed finishing and polishing procedures after 24 hours 0.256 ± 0.002.

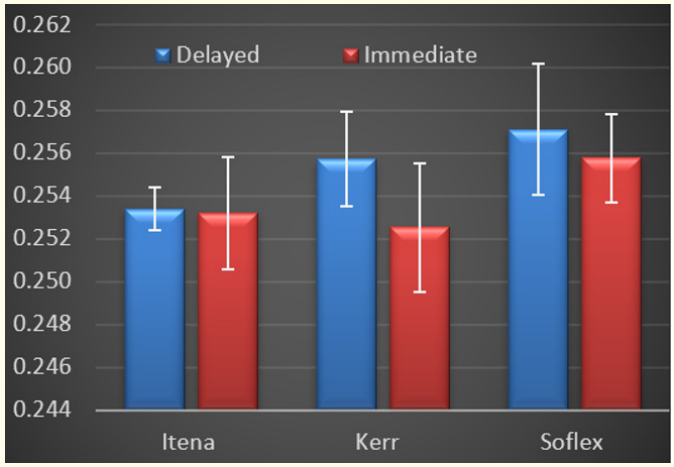

Figure 1: Bar chart mean & SD values of surface roughness of Nano-filled composite (Filtekz350) when immediate or delayed finishing by different systems of finishing and polishing. (c) 14 months postoperatively.

Filtek bulk fill resin composite

- **One step system (Itena perfect polish discs):** When immediately used it showed 0.256 ± 0.002 statistically insignificant P = 0.855 increase in surface roughness compared to delayed finishing and polishing after 24 hours 0.256 ± 0.002.
- **Two steps system (3M Soflex spiral wheels):** When immediately used it showed 0.258 ± 0.002 statistically insignificant P = 0.981 increase in surface roughness compared to delayed finishing and polishing after 24 hours 0.258 ± 0.005.
- **Multiple steps system (Kerr OptiDiscs):** When immediately used it showed 0.255 ± 0.003. statistically insignificant P = 0.060 decrease in surface roughness compared to delayed finishing and polishing after 24 hours 0.256 ± 0.002.

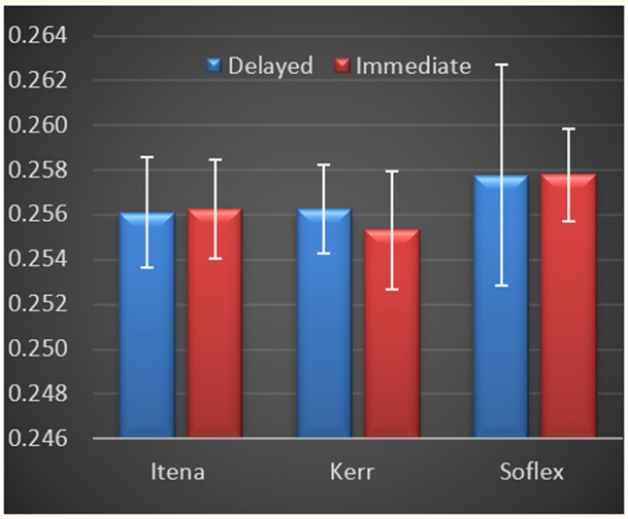

Figure 2: Bar chart mean and SD values for surface roughness of Filtek bulk-fill composite resin material when immediate or delayed finishing and polishing procedures were done by using different finishing and polishing systems.

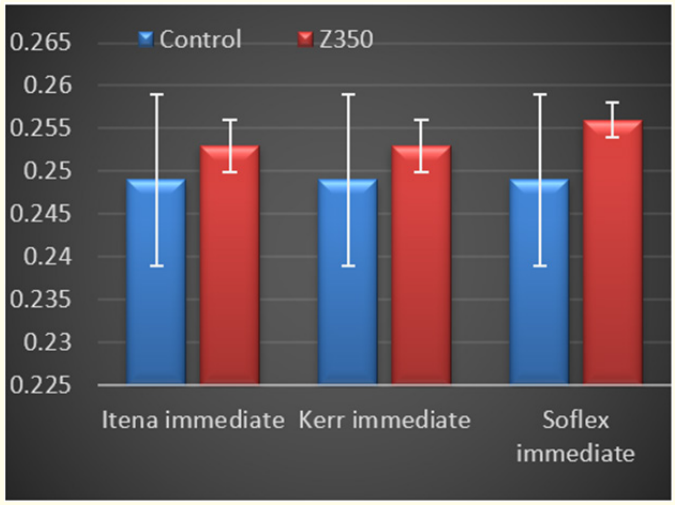

Figure 3: Bar chart mean and SD values for surface roughness of Filtek z350 composite resin material without any finishing and when immediately finishing and polishing by different systems.

According to type of finishing and polishing system:

Filtek z350 Nano filled resin composite

Immediate finishing and polishing in comparison to mylar strips

- **one- step system (Itena perfect polish disks):** Showed insignificant increase P = 0.101 in surface roughness values 0.253 ± 0.003um than when using mylar strips without any finishing and polishing procedures 0.249 ± 0.10um.
- **Two-step system (3M Soflex spiral wheels):** Showed significant increase P = 0.011 in surface roughness values 0.256 ± 0.002 than when using mylar strips without any finishing and polishing procedures 0.249 ± 0.10um
- **Multiple-step system (Kerr OptiDiscs):** Showed insignificant P = 0.170 increase in surface roughness values 0.253 ± 0.003 than when using mylar strips without any finishing and polishing procedures 0.249 ± 0.10um

Delayed finishing and polishing compared to mylar strips

- **One-step system (Itena perfect polish discs):** Showed insignificantly P = 0.063 increase in surface roughness values 0.253 ± 0.001um than when using mylar strips without finishing or polishing procedures 0.249 ± 0.010um,
- **Two-step system (3m soflex spiral):** Showed significant P = 0.006 increase in surface roughness values 0.257 ± 0.003um than when using mylar strips without finishing or polishing procedures 0.249 ± 0.010um
- **Multiple-step system (Kerr OptiDiscs):** Showed significant increase P = 0.013 in surface roughness values 0.256 ± 0.002 than when using mylar strips without finishing or polishing procedures 0.249 ± 0.010um.

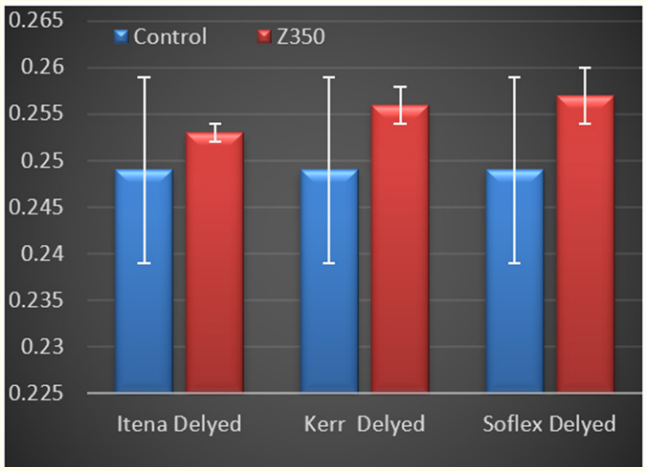

Figure 4: Bar chart representing mean and standard deviation values for surface roughness of Filtek z350 composite resin material without finishing (mylar strip) &when delayed finishing and polishing procedures by different systems.

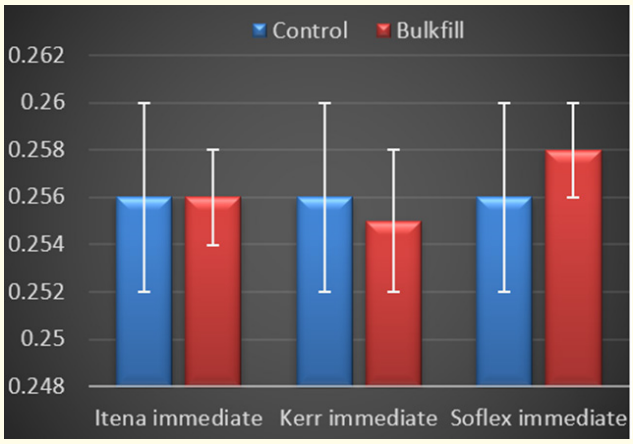

Figure 5: Bar chart mean and SD values for surface roughness of Filtek bulk-fill composite without any finishing and when immediate finishing and polishing by using different systems.

Filtek bulk fill resin composite

Immediate finishing and polishing in comparison of using mylar strips

- **One-step system (Itena perfect polish discs):** Showed insignificant P = 0.844 increase in surface roughness values 0.256 ± 0.002um than when using mylar strips without finishing or polishing procedures 0.256 ± 0.004um.
- **Two-step system (3m soflex spiral):** Showed insignificant P = 0.180 increase in surface roughness values 0.258 ± 0.002um than when using mylar strips without finishing or polishing procedures 0.256 ± 0.004um.
- **Multiple-step system (Kerr OptiDiscs):** Showed insignificant P = 0.653 decrease in surface roughness values 0.255 ± 0.003 than when using mylar strips without finishing or polishing procedures 0.256 ± 0.004um.

Delayed finishing and polishing in comparison of using mylar strips

- **One-step system (Itena perfect polish discs):** Showed insignificant P = 0.938 increase in surface roughness values 0.256 ± 0.002um than when using mylar strips without finishing and polishing procedures 0.256 ± 0.004um.
- **Two-step system (3m soflex spiral):** Showed insignificant P = 0.471 increase in surface roughness values 0.258 ± 0.005 than when using mylar strips without finishing and polishing procedures 0.256 ± 0.004um.
- **Multiple-step system (Kerr OptiDiscs):** Showed insignificant P = 0.848 increase in surface roughness values 0.256 ± 0.002 than when using mylar strips without finishing and polishing procedures 0.256 ± 0.004um.

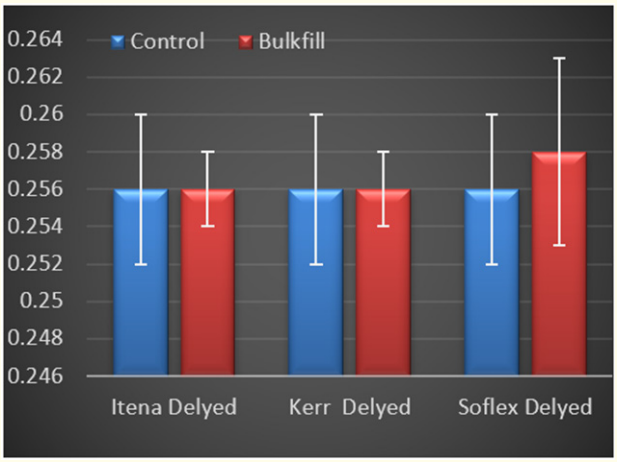

Figure 6: Bar chart representing mean and SD of surface roughness of Filtek bulk-fill composite without any finishing and when delayed finishing and polishing by different systems.

Interaction between variables on mean surface roughness

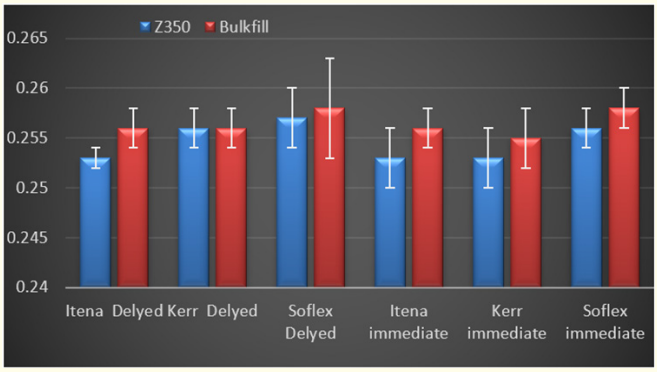

Figure 7: Bar chart representing mean and standard deviation values for surface roughness for interactions between all variables.

Discussion

This study was held to assess the surface roughness of bulk-fill composite material compared to traditional incremental resin composite and the influence of different finishing and polishing systems and time of finishing on their surface roughness. Achieving a restoration's surface smoothness is vital for its success given that the rough surfaces contribute to the deposition of dental plaque and discoloration and later lead to soft tissue damage. surface roughness also affects their mechanical properties by decreasing its resistance and accelerating its abrasion [3].

Filtek Z350 XT was selected in this study as an example of nano-filled resin composite. The combination of both nano-particle and nano-cluster fillers provides increased filler loading, better physical properties and improved polish retention [4]. Filtek Bulk fill resin composite was selected in this study as an example of nano-filled bulk fill resin composite, it contains two novel methacrylate monomers that, in combination, act to lower polymerization stress. Finishing and polishing procedures a wide variety of materials and techniques have been introduced for contouring, finishing, and polishing, but there is no universally ideal flawless method for finishing procedures. In clinical practice, transparent matrices such as a mylar strips are preferred for forming resin composites and producing the smoothest surfaces with highest gloss. However, resin composites polymerize with a clear matrix on the surface will leave an oxygen inhibited layer which is a resin-rich layer that is easily abraded in the oral environment, thus, polishing is required to prevent wear and discoloration on the resin-rich surface [5]. The initial finishing regimen had a greater impact on surface roughness if subsequent polishing was performed with a one-step method compared to a multiple-step method [6]. Thus, in the present study finishing was carried out with extra fine yellow coded diamond burs from Jota Swiss under running water to simulate the clinical finishing procedure. Aluminum-oxide particle-impregnated disks can be regarded as the standard tools in the polishing procedures of direct composite resin restorations, providing the maximum smooth surface by abrading the resin matrix and filler particles uniformly [7]. In our study we used OptiDiscs from KerrHawe as an example of Aluminum-oxide particle-impregnated disks, with a three-grit system instead of the traditional four. Recently, two novel F/P systems, SofLex Spiral Wheels two step system and Perfect polish discs one step system, were introduced for use as reduced-step polishers. These products contain aluminum oxide particles impregnated in wheel bristles and pure diamond powder impregnated in silicone discs respectively. they have special shapes that can fully adapt to occlusal and irregular tooth surfaces. Kemaloglu., *et al.* [8]. concluded that Reduced-step systems used after a prepolisher can be an acceptable alternative to multiple-step systems on enhancing the surface smoothness; however, their effectiveness depends on the materials 'properties. Therefore, this study aimed to evaluate the effect of various reduced-step systems Soflex spiral wheels and

perfect polish discs versus a multiple-step system OptiDiscs on the final surface roughness of two true Nano resin composite, one is bulk fill and the other is conventional layering. In our study strict adherence to manufacturers' instructions on finishing/polishing procedures was thus observed for effectiveness. Efforts were also made to standardize the different aspects of the methodology, including hand piece speed, time of finishing, motion, pressure, total number of strokes employed for each finishing/polishing system and doing all the procedures under magnifying loupes. comparing different polishing motions on restorative materials showed that for all possible combinations of materials and abrasive grits, the planar motion achieved the lowest average roughness values [9]. In this study, all the systems were tested using a planar motion. In this study, the smoothest surfaces were obtained by curing both materials against a matrix strip. This finding was in agreement with previous studies on resin composites [10]. The smoothness obtained with matrix strips [MS] could not be reproduced by any of the finishing/polishing systems. The effect of finishing/polishing systems on surface roughness the technology for two- and one-step finishing/polishing systems has evolved over the last few years and current systems appear to be as effective as multi-step systems for finishing and polishing dental composites. In our study the results showed non-significant difference in surface roughness between multiple step systems and reduced step systems which was in agreement with many studies [11,12]. while Jung., *et al.* 2007 [6] were in disagreement with our results where they showed that multiple step system was superior than reduced step systems. *Time of finishing and polishing* in many studies where the timing and type of polishing system can affect the surface roughness of the composite [13], Others found that no difference in surface roughness among the tested groups [14]. which was in agreement with our results in bulk fill composite. Kaminedi., *et al*. [15]. concluded that immediate finishing and polishing under coolant resulted in the best surface smoothness and hardness values in micro hybrid composite; however, immediate dry finishing and polishing gave the best smoothness and hardness values in nanohybrid composite. Whereas Venturini., *et al*. 2006 [13]. found that generally, immediate polishing produced no detrimental effect compared to delayed polishing. Which was in agreement with our study results in nano filled composite, while Madhyastha., *et al*. 2015 [16]. concluded from their study that smooth surface can be obtained by delaying the finishing and polishing procedures, was in disagreement with our results, however recent material like bulk fill composite still needs research *Surface roughness* Various techniques can be used for assessing surface roughness, for example, qualitative methods, such as optical microscopy and SEM, and quantitative methods, such as surface profile analysis (profilometry) Mostly, optical technique microscopy measurements are needed for supporting the results. Furthermore, a non-contact acquisition excludes surfaces damages that could consequently create bias in the results obtained. Moreover, its capable of measuring an area from the surface rather than a single line in profilometry [17]. Thus, the roughness values obtained are more accurate. In this study, a contact mechanical Profilometer in combination with a 3D image of the surface profile has been used. This technique is capable of providing detailed three-dimensional topographical images of surface roughness. Regarding the statistical analysis of our study, two Way ANOVA was used, the effect of the resin composite type, the effect of finishing system and the effect of time of finishing for mean surface roughness. The results of this study showed that (Filtek bulkfill) showed significant increase of surface roughness $P < 0.05$ than nanofilled composite type (Filtek z350) in all procedures used for finishing and polishing *except* when delayed finishing and polishing is done on Filtek bulkfill by soflex (two-step system) and kerr (multi-steps system) showed insignificant increase in values than Filtekz350.It may be due to that both materials are nanostructures. It was found that filler particles play an important role on the surface roughness of the resin material and also protect organic matrix from wear. These results were in agreement with Katge., *et al*. 2016 [18]. According to Yalcin and Gitrgan, 2005 [19]. the filler size is one of the factors that determines the surface roughness and polishability of the restorative materials. Moreover, Bajwa and Pathak, 2014 [20]. who were in agreement with our study results, found that composites with small filler particles are more homogeneous and their particles are less prominent on the surface, resulting in a lower surface roughness [21]. were in disagreement with our study results as they have mentioned that a smaller filler size does not necessarily result in a low surface roughness and staining susceptibility

Conclusion

Nano filled resin composite exhibited smoother surface than Bulk fill resin composite irrespective of the finishing technique used or time of finishing. Mylar strip created the smoothest surface in both materials. Two step system (3M Soflex spiral) created more surface roughness in both materials. Nano filled composite Filtek Z350 exhibited smoother surface when finished and polished immediately. Bulk fill composite showed better results in surface roughness with multiple- step system (Kerr OptiDiscs) irrespective

of time of finishing. Nano filled material showed better results in surface roughness with using one step system (Itena perfect polish) irrespective of time of finishing.

Further studies can be performed to minimize the limitations of the present study by investigating the effect of function and/or brushing over more extended times along with any future developed techniques to address this issue.

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