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Original Article

Dentistry Section

Effect of Three Different Polishing Systems on Surface Texture of Nanofilled Composite- A Profilometric Study

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ABSTRACT

Introduction: Improper finishing and polishing of composite resins always present a problem to dental practitioner. Advances in composite resin materials and the instruments used for finishing and polishing has revolutionised the art of aesthetic dentistry. This study utilises surface texture of composite resin as a quality of finishing and polishing achieved by polishing systems.

Aim: To evaluate the surface texture of nanofilled composite resin (Filtek Z350XT) polished by Sof-Lex XT, Enhance and PoGo, KerrHawe and OptiDisc polishing systems.

Materials and Methods: In this in-vitro experimental study, three polishing systems were tested for surface texture of a nanofilled composite resin (Filtek Z350XT, USA). A total of 66 specimens (2 cm in diameter and 2 cm in height) were prepared from acrylic mold. Circular cavity measuring 8 mm in diameter and 3 mm in depth were prepared in each specimen. All the cavities were filled with nanofilled composite resin. The filled specimens were divided into 3 groups of 22 each and polished by Sof-Lex XT, Enhance and PoGo, KerrHawe and OptiDisc respectively. The surface roughness was measured by surface profilometer. Data was analysed by using ANOVA test between treatment groups.

Results: The surface roughness (Ra) was less for the Sof-Lex XT group (0.35±0.09) as compared to Enhance and PoGo (0.56±0.14), KerrHawe and OptiDisc groups (0.59±0.15). One-way ANOVA test revealed $p \leq 0.05$ which was statistically significant.

Conclusion: The Sof-Lex XT system was found to be more effective as compared to other two systems.

Keywords: Burs, Disc, Specimen, Surface profilometer, Surface roughness

INTRODUCTION

The continuous search for a tooth-coloured restorative material has resulted in significant improvements in aesthetic dentistry and one among them is the composite resins. Dental composites are defined as polymeric materials which are highly cross-linked and are reinforced by a dispersion of glass, crystalline or resin filler particles and/or short fibers attached to the matrix by silane coupling agent [1,2].

Surface texture or smoothness is an important property of any restorative material. Improper surface finishing and polishing of restoration causes plaque retention, superficial discoloration and secondary caries [3]. However, literature has revealed major concern with finishing and polishing of composite resin [4]. Traditionally various finishing and polishing systems like carbide and diamond finishing burs, abrasive strips, polishing pastes etc. have been used. To overcome the drawbacks of these systems like formation of roughness, generation of frictional heat and creation of tensile and shear stress on restorations, newer generations finishing and polishing agents like aluminium-oxide impregnated discs, silicon cups and points, durable polyethylene discs etc., are being used recently [5]. Previous studies have showed polishability of composite resin materials and the ability of polishing instruments for the same [6-10]. Coupled with aesthetic demand, ever increasing advancement in composite resin materials and finishing and polishing instruments, the present in-vitro study was undertaken to evaluate and compare the effect of these polishing systems (Sof-Lex XT, Enhance and PoGo, KeerHawe and OptiDisc) on the surface texture of nanofilled composite resin (Filtek Z350XT, 3M ESPE, St.Paul, MN, USA).

MATERIALS AND METHODS

This in-vitro experimental study was conducted in the Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth Deemed to be University, Dental College and Hospital, Sangli in collaboration with Department of Mechanical Engineering, Walchand College of Engineering, Sangli, Maharashtra, India. The study was approved by Institutional Ethical Committee on December 7th 2017 (Letter number -BVDUMC and H/Sangli IEC/ Dissertation 2017-18/251) and duration was about 8 months in the calendar year 2019.

In this study, a nanofilled composite resin (Filtek Z350 XT {Universal Restorative, 3M ESPE St.Paul, MN, USA}) and three polishing systems (Sof-Lex XT {3M do Brasil Ltda. Sumare, SP, Brasil}, Enhance and PoGo {DENTSPLY Caulk}, KerrHawe and OptiDisc {Kerr, Switzerland}) were used. The sample size was determined from data obtained from previous research by Scheibe KG et al. (2009), journal of applied sciences and using Gpower 3.0.10 [11].

Sample size estimation:

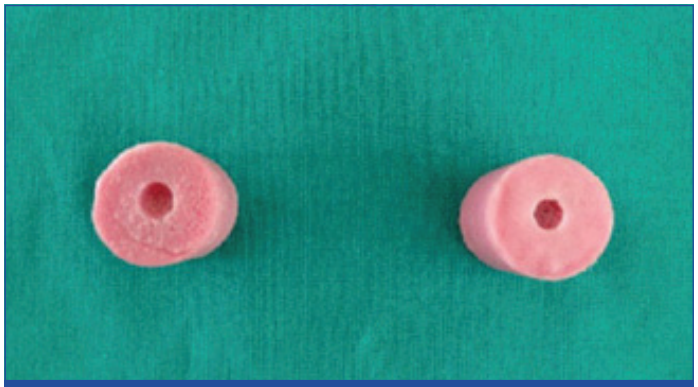
- Input: Tail(s)=Two
  Effect size d=1.1206301
  α err prob=0.05
  Power (1-β err prob)=0.95
  Allocation ratio N2/N1=1
- Output: Noncentrality parameter=3.716710
  Critical t=2.018082
  df=42
  Sample size per group=22
  Total sample size (3x22)=66

Preparation of Specimens

Sixty six acrylic resin (DPI RR cold cure, Mumbai) blocks measuring 2 cm in diameter and 2 cm in height were prepared from plastic mould. Circular cavity measuring 8 mm in diameter and 3 mm in depth was prepared in each acrylic resin block using high speed airotor (>2,00,000 rpm) with round and straight fissure burs. Dimensions

were confirmed with digital vernier caliper. Acrylic resin was used to prepare the specimens because of ease of manipulation, stability and durability [Table/Fig-1,2].

[Table/Fig-1]: Acrylic resin blocks.



[Table/Fig-2]: After cavity preparation.

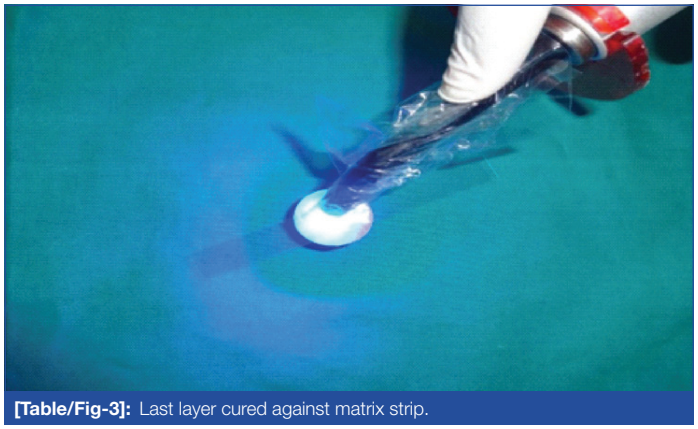
Nanofilled composite resin i.e., Filtek Z350 XT (3M ESPE, St. Paul, MN, USA) indicated for direct restoration was inserted into the prepared cavities using composite packing instruments (GDC) in three increments. Each increment was activated using LED curing unit (Ivoclar vivadent, Austria) for 20 seconds. The last layer was cured against a mylar strip (SHOFU DENTAL GmbH, Japan) with pressure being applied to the ends in order to produce extravasation of the material and the excess material was trimmed. The specimens were stored in distilled water at 37°C for 24 hours [Table/Fig-3,4] [11].

All the specimens were finished with fine grit diamond burs using a high speed hand piece under water cooling and the specimens were divided into three groups (n=22 each).

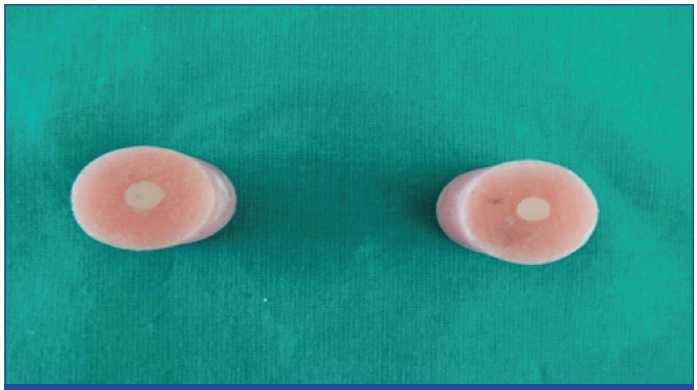
Polishing of Specimens

Group I: 22 Specimens were polished using aluminium oxide-impregnated discs (Sof-Lex XT) polishing system. Sequence of coarse to superfine discs were used for 30s with high speed hand piece on each specimens with light intermittent pressure in the planar motion.

Group II: 22 Specimens were polished using disc-shaped aluminium oxide-impregnated silicon points and cups (Enhance and PoGo) polishing system. Polishing procedure was same as mentioned in group I.



[Table/Fig-3]: Last layer cured against matrix strip.



[Table/Fig-4]: After curing of the samples.

Group III: 22 Specimens were polished using durable polyester discs impregnated with aluminium oxide particles (KerrHawe and OptiDisc) polishing system. Polishing procedure was same as mentioned in group I.

Following are the recommended cut-offs (ISO 4288-1966) for different surface finish [Table/Fig-5] [12].

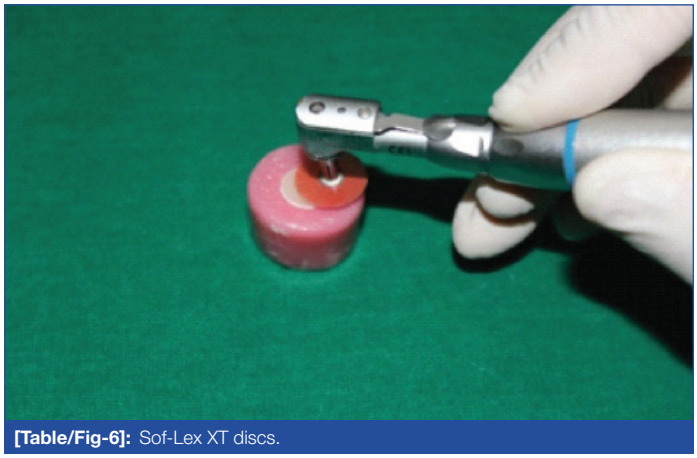
Periodic profiles	Non-periodic profiles	Cut-off	Sampling length
Spacing distance RSm (mm)	Ra (µm)	Λc (mm)	Λc (mm/L)
>0.013-0.04	To 0.02	0.08	0.08/0.4
>0.04-0.13	>0.02-0.1	0.25	0.25/1.25
>0.13-0.4	>0.1-2	0.8	0.8/4
>0.4-1.3	>2-10	2.5	2.5/12.5
>1.3-4.0	>10	8	8/40

[Table/Fig-5]: Recommended cut-offs.
Ra- Surface roughness; RSm- Mean spacing between profile peaks at the mean line, measured within the sampling length

All the procedure was performed by a single trained investigator to avoid operator bias and no blinding was done as it was an in-vitro study and there was one composite resin material tested and the operator was aware of the group to be polished respectively by polishing system. Each specimen was polished with a new polishing disc. All the specimens were washed with an air/water spray to remove debris and air dried and subjected to surface roughness measurement [Table/Fig-6-8].

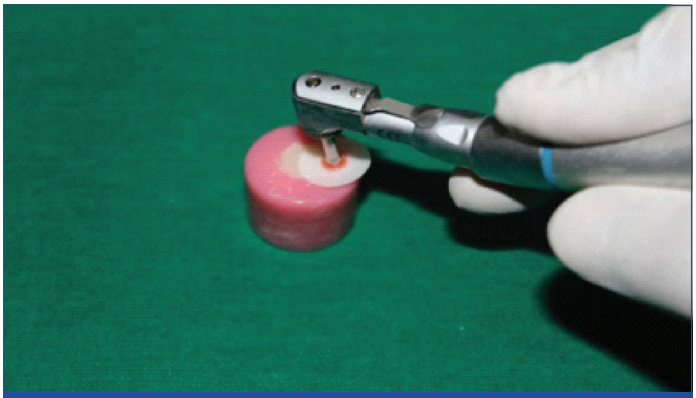
Surface Roughness Measurement

The surface texture of individual specimen in each group was measured by surface profilometer (Surtronic 25, Taylor Hobson Ltd, Leicester, England). A single measurement was recorded for each specimen at the center and the reading was noted by a trained laboratory technician. The surface texture (Ra, in µm) for each specimen was directly observed on the LCD screen connected to surface profilometer [Table/Fig-9,10].



[Table/Fig-6]: Sof-Lex XT discs.

[Table/Fig-7]: Enhance and PoGo.



[Table/Fig-8]: KerrHawe and OptiDisc.

[Table/Fig-9]: Surface profilometer.

[Table/Fig-10]: Reading of surface profilometer.

STATISTICAL ANALYSIS

The data was analysed using SPSS v.20 IBM Corp. USA and the surface roughness between groups was compared by ANOVA. When the difference was statistically significant, Post-hoc tuckey test was used for intergroup comparison. The p-value was kept statistically significant at ≤0.05.

RESULTS

The present in-vitro study was conducted to evaluate and compare the effect of three polishing systems on the surface texture of nanofilled composite resin. When polishing was done by Sof-Lex XT, Enhance and PoGo, KerrHawe and OptiDisc the surface roughness for individual system was 0.35 µm, 0.56 µm, 0.59 µm respectively. The standard deviation was as follows: 0.09, 0.14 and 0.15 [Table/Fig-11].

Groups	N	Mean±SD	F-value	p-value
Sof-Lex XT	22	0.35±0.09	22.940	0.001*
Enhance and PoGo	22	0.56±0.14		
KerrHawe and OptiDisc	22	0.59±0.15		

[Table/Fig-11]: Comparison among Sof-Lex XT, Enhance and PoGo, KerrHawe and OptiDisc polishing systems.
One way anova test; *indicates significant at p≤0.05; SD: Standard deviation

The mean difference between Sof-Lex XT and Enhance and PoGo was 0.2109 µm, between Enhance and PoGo and KerrHawe was 0.0263 µm, between Sof-Lex XT and KerrHawe was 0.2372 µm [Table/Fig-12].

(I) Groups	(J) Groups	Mean difference (I-J)	p-value
Sof-Lex XT	Kerr Hawe	-0.2372727	0.001*
	Enhance and PoGo	-0.2109091	0.001*
Enhance and PoGo	KerrHawe	-0.0263636	0.772 (NS)
	Sof-Lex XT	0.2109091	0.001*
KerrHawe and OptiDisc	Sof-Lex XT	0.2372727	0.001*
	Enhance and PoGo	0.0263636	0.772 (NS)

[Table/Fig-12]: Pairwise comparison of surface texture.
Post-hoc tukey test; *indicates significant at p≤0.05; NS: Non-significant

Hence, it can be inferred that surface texture of Filtek™ Z350 XT polished with Sof-Lex XT polishing system produced significantly smoother surface than the one obtained with Enhance and PoGo and KerrHawe and OptiDisc polishing systems. Results of one-way ANOVA test for surface roughness showed p=0.001 which is statistically significant.

DISCUSSION

Proper finishing and polishing of composite resin restorations are important steps to increase the longevity and aesthetics of restoration. Poorly polished restoration surfaces are susceptible to discoloration, gingival irritation and secondary caries [4]. In the present study, we investigated the surface roughness of nanofilled composite (Filtek Z350 XT) using three polishing systems (Sof-Lex XT, Enhance and PoGo, KerrHawe and OptiDisc) and Sof-Lex XT showed lowest surface roughness value. Surtronic 25 profilometer was used to evaluate surface roughness (Ra). The Ra value was defined as the arithmetic average height of roughness component irregularities from the mean line measured within the sample length [9]. Surtronic 25 is a contact-type (Stylus) surface roughness tester. Even though it has disadvantages like stylus wear and creation of scratches on specimen's surface, it provides reliable measurements as it directly touches the specimen. Also, it is portable and suitable for use both in the workshop and laboratory [12]. Scanning probe microscopy, atomic force microscopy and electron microscopy are the other methods for evaluation of surface roughness. However, these techniques are tedious, time consuming, expensive, requires a trained technician etc., [13].

Regarding the surface roughness, Sof-Lex XT produced the smoothest surface in all groups tested. This can be attributed to the fact that flexible discs of aluminium oxide was more efficient in

removing particulate inorganic filler at the very surface of the organic matrix of the biomaterial [14].

The results of present study are in accordance with the results of Chour RG et al., Barbosa SH et al., Gulati GS and Gulati NK, Nair VS et al., Abzal MS et al., who showed that aluminium-oxide discs are superior than other systems [3,6-9]. However, results of this study are in contrast to the study by Patel B et al., who found that Enhance and PoGo was better polishing system than Sof-Lex spiral [4]. [Table/Fig-13] depicts a comparative evaluation of this study with other similar studies [3,6-9].

Sr. no.	Author	Composites	Polishing systems	Conclusion
1	Barbosa SH et al., [6]	Durafill and Perfection (Microfilled), Filtek Z250 (Nanohybrid), Surefil and Fill Magic (Packable)	Carbide burs, diamond burs, Sof-lex disc, Super-snap, rubber polishing points+paste, Diamond burs+rubber points+paste, Diamond burs+Sof-Lex, Diamond burs+ Super-snap	Lowest Ra means were obtained for the specimens treated with Sof-Lex discs.
2	Gulati GS and Gulati NK [7]	Filtek Z100 (Microhybrid)	Sof-Lex disc, PoGo	Filtek Z100 showed least Ra values with Sof-Lex.
3	Nair VS et al., [8]	Filtek Z350 XT (Nanofill), Esthet-X HD (Hybrid), Te Econom (Microfill), Tetric EvoCeram (Nanohybrid)	Sof-Lex and Enhance + PoGo	Sof-Lex showed the smoothest surface.
4	Chour RG et al., [3]	Nanofilled	Control, Sof-Lex disc, diamond tips, Astrobrush	Sof-Lex group produced lesser surface roughness
5	Abzal MS et al., [9]	Filtek Z350 XT (Nanofill), T-Econom plus (Microhybrid), G-aenial Flo (True nano)	Control, Astrobrush, Astropol, Sof-Lex spiral wheel	Sof-Lex spiral wheel significantly had the least roughness value.
6	Current study	Nanofilled composite resin (Filtek Z350 XT)	Sof-Lex XT, Enhance and PoGo, KerrHawe and OptiDisc	The Sof-Lex XT system was found to be more effective as compared to other two systems.

[Table/Fig-13]: Comparative evaluation with other similar studies [3,6-9].

Clinical implication of this study are that the results of the present study must also be understood with caution since in clinical practice; the use of composite restorative material and polishing systems could be limited to the real accessibility and unvarying nature of the surfaces to be finished [15].

Limitation(s)

The specimens made in this in-vitro studies are relatively flat, uniform as compared to intra oral restorations. The presence of factors like saliva, location of the tooth, temperature, accessibility etc., influence the process of finishing and polishing which were not accounted in this in-vitro study. The study was self-funded and due to financial implications, only experimental groups were involved.

CONCLUSION(S)

Within the limitations of the study, it was concluded that for the nanofilled composite resin (Filtek Z350 XT), among the tested polishing systems, Sof-Lex XT produced better surface texture as compared to Enhance and PoGo and KerrHawe and OptiDisc. Although companies recommend the protocol to use the material/instruments, the dentist need to evaluate and optimise the material/instruments depending on patient's perfection and clinical situation. This being an in-vitro study, future studies should simulate oral conditions to determine the surface texture of composite resin polished by polishing system.

REFERENCES

[1] Hegde MN, Hegde P, Malhan B. Evaluation of depth of cure and knoop hardness in a dental composite, photo-activated using different methods. J Conserv Dent. 2008;11(2):76-81.
[2] Anusavice KJ. Phillips' Science of Dental Materials. 11th ed. Missouri: Elsevier Inc.; 2003.
[3] Chour RG, Moda A, Arora A, Arafath MY, Shetty VK, Rishal Y. 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;6(2):01-06.
[4] 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.
[5] Singh S, Mandlik J, Kanyal K, Jadhav A, Handa A. An in-vitro evaluation of effect of three finishing and polishing systems on the surface of nanofilled composite resin. Int J Civ Eng. 2016;1(2):37-41.
[6] Barbosa SH, Zanata RL, Navarro MF, Nunes OB. Effect of different finishing and polishing techniques on the surface roughness of microfilled, hybrid and packable composite resins. Braz Dent J. 2005;16(1):39-44.
[7] Gulati GS, Gulati NK. The effect of different polishing system on the surface roughness of composite materials. J Head Neck Physicians Surg. 2014;2(2):54-62.
[8] Nair VS, Sainudeen S, Padmanabhan P, Vijayashankar LV, Sujathan U, Pillai R. Three-dimensional evaluation of surface roughness of resin composites after finishing and polishing. J Conserv Dent. 2016;19(1):91-95.
[9] 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;19(2):171-74.
[10] Sudha K, Reddy H, Reddy S, Ch LR. Effect of different polishing systems on the surface roughness of nano-hybrid composites: A profilometric study. Annals and Essences of Dentistry. 2017;9(4):1a-04.
[11] Scheibe KG, Almeida KG, Medeiros IS, Costa JF, Alves CM. Effect of different polishing systems on the surface roughness of microhybrid composites. J Appl Oral Scl. 2009;17(1):21-26.
[12] Surtronic 25. Users Guide. Taylor Hobson Ltd. Ametek Ultraprecision Technologies. England. K505/125-01;2015:4.
[13] Bhushan B. Surface roughness analysis and measurement techniques. In Modern Tribology Handbook. CRC press. c2000; 79-150.
[14] Lopes IA, Monteiro PJ, Mendes JJ, Goncalves JM, Caldeira FJ. The effect of different finishing and polishing techniques on surface roughness and gloss of two nanocomposites. Saudi Dent J. 2018;30(3):197-207.
[15] Magdy NM, Kola MZ, Alqahtani HH, Alqahtani MD, Alghmlas AS. Evaluation of surface roughness of different direct resin-based composites. J Int Soc Prev Community Dent. 2017;7(3):104-09.

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