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Surface Finish of Nanofilled Composites with Identoflex, Shofu and Blaze Aesthetic Polishing Kits – A Surface Roughness Analysis

Revathi Palanisamy, Subha Anirudhan*, V. Prabhakar, Minu Koshy, A. S. Sriman Narayanan, P. Ambalavanan

[1]. B.D.S- PG Student, [2.]M.D.S., - Professor, [3.] M.D.S.Head of the Department, [4.] M.D.S., Professor,[5.] M.D.S- Reader, [6]. M.D.S., - Reader,
Department of Conservative Dentistry and Endodontics,
Sri Ramakrishna Dental College and Hospital,
Coimbatore, Tamil Nadu, India

***Corresponding Author:**

Subha Anirudhan
Professor
Department of Conservative Dentistry and Endodontics,
Sri Ramakrishna Dental College and Hospital,
Coimbatore, Tamil Nadu, India

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ABSTRACT

It is clinically important to determine the finishing technique that results in the smoothest surface with the minimum time and instruments. The proper finishing and polishing of dental restoratives are significant to promote a plaque-free environment and to enhance the esthetics and longevity of restoration.This study aimed to investigate the influence of different polishing systems on the surface roughness of nano-filled composites. Sixty cylindrical composite specimens [NanofilledFiltek™ Z350 XT (3M ESPE)] of 10mm diameter and 3mm height, were made in teflon moulds with Mylar strip placed over the final increment and stored in water for 24 hours. The finishing and polishing of the samples was carried out with Group 1: No polishing, Group 2: Kerr Identoflex diamond polisher, Group 3: Shofu polishing kitand Group 4: MediceptBlaze polishing kit according to manufacturers' instructions. The polished surfaces were then assessed with a Surface Roughness Tester (Mitutoyo SJ 210, Japan) and statistically analysed. There was no statistically significant difference between the groups tested. The smoothest surfaces were obtained from the Mylar strip. Among the polishing systems, Identoflex showed the smoothest surface. The ranking of mean Ra values by polishing system used was : Mylar strip group<Kerridentoflex kit<Blaze aesthetic polishing kit<Shofu polishing kit. The effectiveness of the polishing systems seems to be dependent on the material used and abrasive present. Identoflex seemed to be a better polishing system than Shofu and Blaze aesthetic.

Keywords: Aesthetics, Composite resin, Polishing system, Roughness tester, Surface roughness.

INTRODUCTION

In recent years, growing public interest in cosmetic procedures has had a positive impact on use of aesthetic restorative materials, primarily composites. One of the shortcomings of the material, however, lies in the difficulty in producing a well-polished surface [1]. The surface of restorations has to be smooth to reduce bacterial plaque retention at the margins and cavosurface areas of the restoration to prevent secondary caries and gingival irritation [1, 2, 3].

Finishing and polishing enhances the longevity, colour stability and wear resistance of the restoration. A highly polished surface increases the reflective and

refractive index of the restoration to create more natural and aesthetic smiles. Clinically, matrix strips can produce a smoother surface but, this will result in an unstable resin rich layer on the top which needs to be removed [4, 5]. Some functional adjustment is also necessary for almost all the restorations.

Roughness is mainly influenced by the composite resin filler, polishing instruments and techniques employed for finishing and polishing. A poor finishing /polishing technique or the instruments can affect the surface quality of the restorations [1, 2, 3].

With the advancement of material science, nanotechnology has been adapted to composites as nanocluster and nanofilled composites. This technology has reduced the interstitial spaces among the inorganic particles with better filler loading, and has resulted in improved physical properties and surface polish. It is clinically important to determine the finishing technique that results in the smoothest surface with the minimum time and instruments.

There are many finishing and polishing materials available in dentistry depending on abrasives present and type of the instrument. The abrasive present in the polishing system has to be harder than the filler particle in the composite. If not, it will lead to selective removal of resin matrix and leave the fillers protruding from the surface [6].

Shofu composite polishing system (Shofu) is an alumina based polishing system used widely for finishing composites. Identoflex diamond composite polishing kit (Kerr) and dental blaze aesthetic composite polishing kit (Medicept) are newly introduced polishing systems that claim to achieve high surface polish. To the best of our knowledge no studies have been conducted on the polishing ability of Identoflex and Dental blaze on surface finish of nanofilled composite resins. Hence, this in vitro study aimed to investigate the influence of different polishing systems on the surface roughness of nanofilled composite resins.

MATERIALS AND METHODS:

Three finishing and polishing systems were studied for this study:

The systems used were,

(1) Identoflex diamond composite polisher –high gloss(Kerr –Switzerland)

(2) Shofu composite polishing kit (Shofu Inc. – Japan)

(3) Blaze aesthetic composite polishing kit(Medicept dental- Switzerland)

The resin composites evaluated were a NanofilledFiltek™ Z350 XT (3M ESPE - USA).

Using Teflon moulds of 10 mm diameter and 3 mm height, a total of 60 samples were prepared. The composite material was filled in the Teflon mould with a composite filling instrument and cured with matrix strip (Samit products, Jhadewalan, New Delhi) on the surface of the composite. All specimens were light cured with the same unit (LEdition, IvoclarVivadent).Each side of the two-sided samples was cured for 30s.The samples were further cured for additional 60s from both sides with the matrices in place. Then the samples were removed from the mould and were stored in water at 37°C ± 5° for 24 h.

The composite samples were mounted on the self-cure acrylic and randomly assigned to four groups (n = 15 each) based on the type of polishing system used;

Group 1: (control) Restorative materials were polymerized with the Mylar strip on top of the specimens and no finishing or polishing systems were used

Group 2: Polishing was done with Identoflex Diamond Composite Polishers (Kerr) with the active zone (impregnated with diamond grit- blue colour) for 30 s at 15,000 rpm with a low-speed hand piece for each sample.

Group 3: Shofu polishing kit was used for 30s at 15,000 rpm with a low-speed hand piece for each sample in the following sequence: Dura-Green stones (silicon carbide) and Dura-White stones (aluminum oxide) for finishing followed by Composite polishers (aluminum oxide) for pre - polishing and Composite Fine instruments for high gloss.

Group 4: Blaze aesthetic composite polishing kit (Medicept dental) was used in the following sequence: Pre polishers and polishers followed by high gloss polishers for 30s with low speed hand piece.

The polishing procedure was varied according to the polishing system used .The four groups were polished according to the respective manufacturers'

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instructions. To reduce the variability, all the procedures were performed by the same operator. All polishing materials were discarded after every use.

Surface roughness was measured using a surface roughness tester (Mitutoyo SJ 210, Japan). Figure 1 shows surface roughness tester with composite specimen. Specimens were positioned according to the instrument with the help of self-cure acrylic. The stylus was placed on the edge of the composite and three successive measurements in different directions were recorded with a 0.2 mm/sec cut-off value and a 0.25 mm/sec stylus speed. The average surface roughness (ra) values were obtained for all specimens, tabulated and subjected to statistical analysis.

RESULTS:

Means and standard deviations were calculated for surface roughness. Anova test was used to evaluate the inter and intra group comparison. Tukey's post hoc test was used for multiple comparisons between groups.

The mean values and standard deviations of surface roughness (ra, µm) for each group are listed in table 1. Specimens polished with kerr identoflex polishing kit (group ii) created similar smooth surfaces as with mylar strip group (group i). Highest mean surface roughness was found with shofu composite polishing kit (group iii). Kerr identoflex polishing kit (group ii) created maximum smoothness among all the polishing systems tested.

None of the polishing systems achieved equally smooth surfaces as that of Mylar strip group. The ranking of mean Ra values by polishing system used was as follows: Mylar strip group<Kerridentoflex kit<Blaze aesthetic polishing kit<Shofu polishing kit.

DISCUSSION:

Proper finishing and polishing is important for several reasons. Clinically correct anatomic contour of the restoration is rarely achieved by using only a Mylar strip and also results in a unstable resin rich layer [4]. Finishing and polishing greatly enhances the longevity, colour stability and wear resistance of the restoration [2, 7, 8]. A smooth surface reduces the likelihood of adhesion of plaque and gingival irritation, because a smooth surface is biologically compatible with the gingival tissue [1, 2, 3]. A highly polished smooth surface increases the reflective and refractive index of the restoration to create more natural and aesthetic smiles.

According to Sotres et al, histologic evidence of gingival inflammation was associated more with unfinished resin restorations than when the materials were finished or polished [9]. A recent study showed a positive correlation between the surface roughness and the discolouration of restorative resins [10]. Another study reported that surface roughness of more than 0.3µm could be detected by the tip of the patient's tongue [11]. Hence a polished surface is necessary to improve the patient comfort, and prevent the surface staining of the restorations.

The effectiveness of finishing/polishing systems depends on filler size of composite material, type and hardness of abrasive used, flexibility of the backing material, time spent with each abrasive and its manner of use, amount of pressure applied, orientation of abrading surfaces and geometry (discs, cups, cones) of abrasive instruments [5]. In our study, composites were polished in the best possible manner with the different polishing kits by the same operator.

Teflon moulds were used to make specimens in this study. Harrington and Wilson have found that the depth of cure was greater for the samples cured with 10s irradiation in the teflon mould than in the stainless steel mould, independent of the shade [12].

3M ESPE Filtek™ Z350 XT Nano Hybrid Universal Restorative is a visible light-activated Nanofilled composite with a particle size distribution range of 0.2 to 1 microns. The spherical shaped nano sized particles are sintered with nano cluster particles because of which it has smaller average filler size but higher filler load [13]. With more filler load, the composite resin will be better polished since more filler particles will be in contact with the polishing instrument to minimize excessive abrasion of the resin matrix. Composite cured with mylar strip placed over the final increment was used as a control group in this study as it has been shown by studies to have the smoothest surface [14, 15].

Identoflex Diamond Composite Polishers, based on twin-zone technology have only the active zone impregnated with diamond grit (Blue colour) and non-active zone without grit (White colour). Shofu composite polishing kit is a three stage system

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containing dura-green silicon carbide stone for adjusting, dura- white aluminium oxide stones for finishing and silicone points impregnated with aluminium oxide for polishing. Blaze aesthetic composite polishing kit is a three stage polishing system that contains pre polishers, gloss polishers and high gloss polishers to be used sequentially.

Profilometers are widely used to measure surface profile, in order to quantify the roughness of any surface. These are contact-type of instruments equipped with a stylus, which traces the surface of the sample. The vertical motion of the stylus is electrically detected and the induced voltage is amplified and recorded. This contact type of instrument gives quantitative results and enables the sample surface to be studied more precisely, as the stylus sweeps the sample surface detecting tiny variations [16]. Ra is the arithmetic mean of the absolute values of the profile deviation from the mean line. Other parameters to measure the roughness are the sum of the height of the largest profile (Rp) and the largest profile valley depth within the evaluation length (Rv). However, there is an impossibility to measure the homogeneity in the maximum profile valley height and depth. Hence Ra value was preferred and high precision surface roughness tester was used in this study to evaluate the surface roughness [17, 18].

The order of surface roughness ranked according to composite polishing kit was: control group < Kerr Identoflex composite polisher < Dental blaze composite polishing kit <Shofu composite polishing kit. In this study, the better polishing ability of Kerr system may be attributed to harder diamond (7000 KHN) particles as compared to aluminium oxide (2100 KHN). This may be the reason for the low mean surface roughness of composites polished with Kerr polishing system containing diamond grit. According to Reis AF et al, diamond particle containing polishing system produced a clinically acceptable surface with relatively short polishing duration [19].

These results are similar to a study, where surface of nano filled and micro hybrid composite showed highest roughness values with Shofu polishing system [20]. Another study reported that disks containing fine diamond particles resulted in significantly smoother surface than aluminium oxide integrated disks [21].

Contrary to our findings, one study found that surface finish produced by diamond abrasives was rougher than the surface finish produced by aluminum oxide. However, the study used aluminium oxide wheels for polishing, which are more flexible and hence, could be a reason for the difference in findings [22]. Some investigators have shown that flexible aluminum oxide disks are the best instruments for providing low roughness on composite surfaces [23 -24]. Hence we may use aluminium oxide disks instead of aluminium oxide stones or points to get a smoother surface.

Evaluation of the surface roughness was done two dimensionally in this study, which could be a limitation. Atomic Force Microscopy (AFM) is a recent technique that provides a 3D profile on a nanoscale, by measuring forces between a sharp probe and surface of the object at very short distances [0.2 to 10 nm]. This helps to measure roughness three dimensionally. AFM, though expensive and not easily accessible now, may be the instrument of choice for measuring roughness in future studies [25].

CONCLUSION:

Within the limitations of this study, it can be concluded that There was no statistically significant difference observed between the mean surface roughness values in the four groups tested Kerr Identoflex polishing kit created maximum smoothness among all the polishing systems tested, similar to the mylar strip group, and Highest mean surface roughness was observed for Shofu polishing kit.

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FIGURE 1:

TABLE – 1

Surface roughness

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Unpolished Composite	15	.1547	.06183	.01955	.1105	.1989	.09	.28
polished with Kerr identoflex kit	15	.1548	.07535	.02383	.1009	.2087	.05	.26
polished with Shofu polishing kit	15	.2182	.04720	.01492	.1844	.2520	.15	.28
polished with Medicept dental blaze kit	15	.1821	.04854	.01535	.1474	.2168	.11	.28

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polished with Shofu polishing kit	15	.2182	.04720	.01492	.1844	.2520	.15	.28
polished with Medicept dental blaze kit	15	.1821	.04854	.01535	.1474	.2168	.11	.28
Total	60	.1774	.06281	.00993	.1574	.1975	.05	.28

Figure 1: Surface roughness tester with composite specimen.

Table 1: The mean values and standard deviations of surface roughness (Ra, µm) for each group.

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