Original Article

Effect of different polishing systems on the surface roughness of nano-hybrid composites

Brijesh Patel, Naveen Chhabra, Disha Jain

Department of Conservative Dentistry and Endodontics, K.M. Shah Dental College and Hospital, Sumandeep Vidyapeeth, Piparia, Vadodara, Gujarat, India

Abstract

Objective: The study aimed to investigate the influence of different polishing systems on the surface roughness of nano-hybrid composite resins.

Background: Different shapes of polishing systems are available according to the site of work. To minimize variability, a new system with single shape is developed that can be utilized in both anterior as well as posterior teeth.

Materials and Methods: Seventy composite discs were fabricated using Teflon well (10 mm × 3 mm). Two main group of nano-hybrid composite Group I — Filtek Z350 and Group II — Tetric N-Ceram were used (n = 35 for each group). Both groups were further divided into four subgroups. Subgroup a — OneGloss (n = 10), Subgroup b - PoGo (n = 10), Subgroup c — Sof-Lex spiral (n = 10), Subgroup d - Mylar strip (control, n = 5). Samples were polished according to the manufacturer's recommendations. Surface roughness test was performed using contact profilometer. The obtained data were analyzed using the one-way analysis of variance test.

Result: Tetric N-Ceram produced smoother surfaces than Filtek Z350 ($P < 0.05$). Mylar strip and "PoGo" created equally smooth surfaces, while significantly rougher surfaces were obtained after applications of "Sof-Lex spiral" and "OneGloss" ($P < 0.05$).

Conclusion: Polishing ability of Tetric N-Ceram is better than Filtek Z350 XT. "PoGo" seems to be a better polishing system than "OneGloss" and "Sof-Lex Spiral."

Keywords: Composite resin; dental polishing; esthetics

INTRODUCTION

Enormous esthetic demands have led the dentists to adopt the resin composite restorations in routine dental practice.[1] Surface roughness of the dental restorations remains a striking problem associated with the use of direct composite resins[2] which increases plaque retention resulting in gingival inflammation, superficial discoloration, and secondary caries. On the contrary, smooth, highly polished restorations are shown to be less susceptible to plaque accumulation and extrinsic discoloration; bear improved mechanical properties.[3]

The performance of a composite restorative is also dependent upon the type and size of the filler. Usually, a composite with smaller size filler particles provides better surface finish than one containing larger filler particles. Refinements in the particle size through enhanced milling and grinding techniques have resulted in composites with particles that are sub-micron (nano-hybrid), typically averaging about 0.4-1 μm and generally considered to be the universal composites as they can be used for most anterior and posterior applications owing to excellent strength and polishing ability.[4]

Address for correspondence:
Dr. Naveen Chhabra, Department of Conservative Dentistry and Endodontics, K.M. Shah Dental College and Hospital, Sumandeep Vidyapeeth, Piparia, Vadodara, Gujarat, India.
E-mail: drnaveenchhabra@yahoo.com

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A variety of finishing and polishing procedures are routinely employed such as carbide burs, diamond points, abrasive disks, abrasive finishing strips, and polishing pastes. Recently, one-step polishing systems such as PoGo® (Dentsply/Caulk, Milford, DE, USA) and OneGloss® (Shofu INC, Japan) are introduced by which contouring, finishing, and polishing can be completed using a single instrument in minimal time.[5] PoGo® is a one-step diamond micropolisher and OneGloss® is an aluminum oxide finisher and polisher, which provide ideal finish for all types of composite and cemented restorations. Recently, Sof-Lex™ spiral wheels (3M ESPE, St. Paul, USA) have been developed which is the only system having a universal design that facilitates finishing and polishing in all the regions of the tooth.[6] It consists of two-step finishing and polishing elastomeric wheels impregnated with aluminum oxide powder particles.

Assessment of Surface roughness using profilometer has been the criterion to measure and predict the deterioration of restorations of different material types.[7] The most commonly used parameter to describe surface roughness is Ra, which is the arithmetic mean of vertical departure of a profile from the mean.[8,9]

Although the surface finish of composites has been widely investigated both in laboratory as well as clinical studies,[10] information about the quality of surface finish from different polishing systems on the surface roughness of nano-hybrid composite resin is scarce and limited. Therefore, this *in vitro* study was aimed to investigate the influence of different polishing systems on the surface roughness of two different nano-hybrid composite resins. The null hypothesis for the present study stated that there shall not be any difference in the polishing ability of either the tested polishing systems or the experimental nano-hybrid composites.

MATERIALS AND METHODS

Seventy identical Teflon wells were fabricated (10 mm diameter and 3 mm height) and randomly assigned to two groups (n = 35 each) based on the type of restorative material; Group I — Tetric N-Ceram™ (Ivoclar Vivadent, Mumbai, India) and Group II — Filtek Z350™ (3M ESPE, St. Paul, USA). Each group was further subdivided into four subgroups based on the polishing regimen used as follows: Subgroup Ia and IIa — OneGloss® (Shofu INC, Japan) (n = 10), Subgroup Ib and IIb - Pogo® (Dentsply/Caulk, Milford, DE, USA) (n = 10), Subgroup Ic and IIc — Sof-Lex™ spiral (3M ESPE, St. Paul, USA) (n = 10) and Subgroup Id and IId — Mylar strip (control) (n = 5). Restorative materials were polymerized according to manufacturer's instructions using an LED curing light (LEDition, Ivoclar Vivadent, Liechtenstein, USA) placed perpendicular to the specimen's surface at a distance of <1.0 mm. Specimens were examined for obvious voids, labeled on the bottom, and randomly separated as per subgroup treatment protocol. Except for the Mylar strip groups, specimens in the other three subgroups were wet-grounded for 30 s with 1200-grit silicon carbide paper on a metallurgical finishing wheel to provide a baseline before applying the polishing systems. The polishing procedure was varied according to the polishing system used as follows: Subgroup Ia, IIa — OneGloss (Shofu) polishing disk was used for 30 s at 15,000 rpm with a low-speed handpiece for each sample. Subgroup Ib, IIb — The flat, broad surface of PoGo diamond micro-polisher disk was first applied using light hand pressure, followed by a gentle buffing motion for 30 s at 15,000-25,000 rpm with a low-speed handpiece. Subgroup Ic, IIc - First the finishing wheel was used followed by the polishing wheel for 30 s each with moderate pressure applied with a handpiece speed of 10,000-20,000 rpm. Subgroup Id, IId (control) — Restorative materials were polymerized with the Mylar strip on top of the specimens and no finishing or polishing system were used. To reduce the variability, the same operator performed all the procedures. All polishing materials were discarded after every use. The prepared samples were stored at 37°C for 24 h in 100% humidity. Surface roughness test was performed with a contact profilometer (Perthometer, Mitutoyo, S j-201p) having a diamond tip stylus with a tip diameter of 2 μm. Three successive measurements in different directions were recorded for all specimens in each group, and the average surface roughness (Ra) value was obtained. The cut-off value for surface roughness was 0.25 mm, and the sampling length for each measurement was 1.25 mm.

RESULTS

Independent Sample t-test and *post-hoc* tests were used to compare the means between two groups and one-way analysis of variance was used to evaluate the intra-group comparison (confidence interval = 95%). Tetric N-Ceram (Group I) provided smoother surface finish as compared to Filtek Z350 (Group II) (P = 0.04; confidence interval = 95%; degree of freedom = 68). PoGo Group (Ib, IIb) created similar smooth surfaces as with Mylar strip Group (Id, IId), while significantly rougher surfaces were obtained after applications of Sof-Lex Spiral Group (Ic, IIc) and OneGloss Group (Ia, IIa) (P < 0.05) in both the main groups. None of the polishing systems achieved equally smooth surfaces as that of Mylar strip group (P < 0.0001). However, PoGo (Ib, IIb) created maximum smoothness among all the polishing systems tested [Figure 1].

DISCUSSION

Finishing and polishing of resin composite restorations are critical steps to enhance the esthetics and longevity

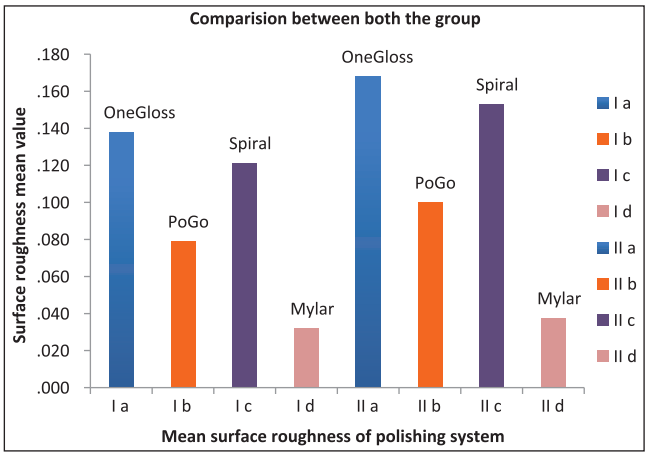

Figure 1: Graphical representation of the mean score of surface roughness of all the polishing systems

of restored teeth.[10] Poorly polished restorations are susceptible to surface discoloration, plaque buildup, gingival irritation, and recurrent caries.[11] The surface quality of resin composite restorations is associated with the polishing quality along with its inborn physical properties like volume, hardness, quantity of filler particles and organization of the resin matrix.[12]

The present study employed wet 1200-grit silicone carbide paper (average abrasive particle size: 30 μm) for finishing the resin composite surface to simulate the clinical scenario as similar particle size abrasives are incorporated to most dental finishing instruments.[13]

Mylar strip produced perfectly smooth restoration surface, although it is rich in the resin organic binder. Finishing and polishing in such a case results in harder, more wear resistant and esthetically pleasing surface which is attributed to the removal of the superficial resin layer.[14]

The efficiency of abrasive systems is related to the flexibility of the backing material in which the abrasive is embedded, the hardness of the abrasive, geometry of the instrument and its manner of use. The abrasive particles must be relatively harder than the filler of composite for a finishing system to be effective. If not, the polishing agent will only remove the soft resin matrix and leave the filler particles protruding from the surface.[15] In the present study, PoGo polisher produced smoother surfaces than OneGloss and Sof-Lex spiral wheel similar to previous studies.[16] PoGo is a flexible micro-polisher disk with fine diamond particles whereas, Sof-Lex spiral contains elastomeric impregnated with aluminum oxide particles, and OneGloss is polyvinylsiloxane impregnated with aluminum oxide. The excellent polishing ability of PoGo may be attributed to lower surface roughness and harder diamond (7000 KHN) particles as compared to aluminum oxide (2100 KHN).[17] Furthermore, visual inspection of the polished specimens with PoGo revealed an enamel-like glossy surface while OneGloss and Sof-Lex-Spiral Wheel system created a duller appearance.

Comparatively better surface finish in the case of Tetric N-Ceram (Group I) could be linked to the relatively less hard filler constituents as Tetric N-Ceram has barium glass (1.25 moh's), ytterbium fluoride (206 KHN) filler whereas Filtek Z350 consists of zirconia (1600 KHN) and silica (820 KHN) as fillers.

The Sof-Lex spiral wheel is a two-step technique whereas OneGloss being a single step polishing system. In the present study, Sof-Lex spiral wheel resulted in better surface finish than the OneGloss in agreement with the earlier studies where multistep polishing systems resulted in better surface finish than the single step.[18]

In the composition of resin composites, an interdependent relationship exists between the amount of inorganic filler particles and that of the organic matrix. In the present study, Group I showed better results than Group II. It may be attributed to higher filler loading of Tetric® N-Ceram (82.5% W^{-1}) as compared to Filtek Z350 XT (78.5% W^{-1}) and so the resin matrix content of Filtek Z350 (20-25% W) is higher than the Tetric® N-Ceram (10-15% W), which makes the polishing of Filtek Z350 more difficult.[19]

This study utilized two-dimensional (2D) profilometry for quantitative assessment of the surface characteristics of the polished composites as used in previous research;[20] however, three-dimensional profilometry could have provided a complete description of the surface topography. In addition, the atomic force microscopy equipped with a 0.01 μm tip would have offered a much better spatial resolution of the traced surface.

According to Chung,[21] the Ra value determined by 2D profilometry was <1 μm when the composite surfaces were visibly smooth. On the other hand, if 2D surface roughness (Ra) were above 0.2 μm, it exceeded the clinically acceptable threshold for composite resin restorations. According to Bollen *et al*.,[22] higher Ra values were accompanied by increased plaque accumulation and a higher risk for dental caries and periodontal diseases. However, other studies reported that there is no difference in plaque accumulation throughout the roughness (Ra) range of 0.7-1.4 μm.[23] In the present study, all the polishing systems were in the range of 0.3-1.8 μm.

CONCLUSION

The null hypothesis was rejected in the present research. Therefore within the limitation of the present study it can

be concluded that polishing action of PoGo is better then the OneGloss and Sof-Lex Spiral Wheel. In addition, Tetric N-Ceram seems to be better in context to polishing ability, than Filtek Z350. However, the *in vitro* nature of this study makes its clinical implication arduous.

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Conflicts of interest

There are no conflicts of interest.

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