INTRODUCTION

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. Weitman and Eames stated that plaque accumulation occurs on composite surfaces with a roughness of 0.7-1.44 μm. [1] Early studies have shown that curing composite against a matrix strip will produce the smoothest surface. [2] [3] Unfortunately, in the clinical environment such a finish cannot be obtained, further some degree of finishing and polishing of restorations is usually necessary.

With the advancement of technology and material science, there is a drastic development of restorative composite resins and the finishing and polishing systems. The composite resins are generally classified according to the size, content, and filler type. The newer classification includes the nanoparticles and a mixture of particle sizes known as a hybrid, microhybrid, or minifill. [4] [5] [6] Studies have shown that filler size and shape can affect the surface roughness of composite resins. [7]

This study determined how the matrix and filler compositions of restorative materials influenced the ease with which they could be polished using the two polishing systems: Soflex (3M ESPE) and Enhance + Pogo (Dentsply Caulk). Several authors have studied the evaluation of surface roughness of composites using mechanical profilometry. In this study, optical profilometer has been used for evaluation.

Optimal profilometer is a three-dimensional analysis method that provides both qualitative and quantitative representation, unlike with mechanical profilometer: here, the measuring device is optical beam. This device works on Descartes’ law, i.e., a plane wave falling on a plane surface that is not totally absorbent undergoes reflection and propagates as a plane wave in the direction given. The apparatus works by measuring the distance between an internal reference and point of the surface. [8]

Materials and Methods

For this study, four composites and two finishing and polishing systems were studied: The resin composites evaluated were a Nanofill composite (Filtek Z350), Nanohybrid (Tetric EvoCeram), Hybrid (Esthet XHD), and Minifill (Te Econom). The finishing and polishing systems used were Enhance and Pogo kit (Dentsply Caulk) and Soflex kit (3M ESPE).

The study was conducted in the Department of Conservative Dentistry and Endodontics, Yenepoya Dental College Mangalore, India and Tata institute, Bangalore, India.

The methodology used in this study is described under the following subheadings:

Preparation of specimens
Polishing of specimens
Surface roughness measurement
Statistical analysis.

Preparation of specimen

Using a Plexiglass mold (8 mm × 2 mm), disc specimens were prepared. For each resin composite, 45 discs were fabricated and a total of 180 discs were obtained. Fifteen specimens per resin composite received no finishing treatment after being cured under Mylar strips and served as a control group. The resin composites were placed using a plastic instrument and covered with Mylar strip. A glass slide of 1-2 mm thick was placed over the strip before curing with light activated source to flatten the surfaces. The samples were then cured for 60 s through Mylar strip and glass slide. Output of light was checked using radiometer (so as to be in excess of 500w/cm 2 ). The curing unit was moved on both sides of the specimen for an additional 20 s after removing the strips and glasses. The cured samples were then stored in distilled water at 37°C for 24 h prior to finishing procedures. After storage, the Mylar strips were removed. The strips were then removed by hand polishing using Soflex disks (For 1 minute). The samples were then polished using 1200 grade water paper (For 1 minute). The samples were then polished using 4000 grade water paper (For 1 minute). The samples were then polished using a pumice mixture and polishing paste (For 1 minute). The samples were then polished using Diamond polish and polishing paste (For 1 minute). The samples were then polished using Diamond polish and polishing paste (For 1 minute). The samples were then polished using a pumice mixture and polishing paste (For 1 minute).

Surface roughness measurement

Surface roughness was measured using a three-dimensional profilometer (FT-200, Tencor, USA). The apparatus works by measuring the distance between an internal reference and point of the surface. [8] The device is optical beam. This device works on Descartes’ law, i.e., a plane wave falling on a plane surface that is not totally absorbent undergoes reflection and propagates as a plane wave in the direction given. The apparatus works by measuring the distance between an internal reference and point of the surface. [8]

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Polishing of specimens

For the first group, Sof-Lex™ 3M pop on discs at medium, fine, and superfine grits were used for 30 s each on the composite samples. After each step of polishing, all specimens were thoroughly rinsed with water and air-dried before the next step until final polishing. The second group was polished with Enhance discs followed by Pogo Dentsply discs. Each was applied for 30 s. For Pogo, first application was done with light intermittent pressure then with decreased pressure to increase the surface luster. The polished resin composite discs were washed, allowed to dry, and kept in distilled water at 37°C for 24 h before measuring average surface roughness (Ra).

Surface roughness measurement

The mean surface roughness of specimens was measured with an optical profilometer. The specimens were scanned at a higher resolution with optical beam. The optical profilometer shows the three-dimensional topography of the specimens, allowing the materials to be classified according to the aspect of their surfaces.

RESULTS

The mean values and standard deviations of surface roughness for each resin composite are given in [Table 1], [Table 2], [Table 3], [Table 4], and [Table 5]. The Kruskal-Wallis test shows significant surface roughness among the four resin composites and two polishing systems (P = 0.001). The smoothest surfaces for all the resin composites tested were obtained against the Mylar strip; statistically significant differences were observed among them (P = 0.001). The order of composites ranked from the lowest to highest surface roughness was Filtek Z350 < Te Econom < Tetric EvoCeram < Esthet XHD. The smoothest surfaces occurred for Teric EvoCeram, which was not statistically different from Esthet X HD. Among the polishing systems, Soflex showed the smoothest surface and was significantly different from Pogo (P = 0.046). Soflex exhibited the smoothest surface for Te Econom and roughest surface for Esthet XHD. Pogo exhibited the smoothest surface for Z350 and Teric EvoCeram and roughest surface for Tetric EvoCeram.

The three-dimensional profiles obtained by the optical method enabled a first appreciation of the surface states of each composite as shown in [Figure 1], [Figure 2], [Figure 3]. Rougher appearance is noticeable for Tetric EvoCeram and Esthet X HD. Soflex exhibited the smoothest finish for nanofill and microfill. (Figure 1) (Figure 2) (Figure 3)

DISCUSSION

The smoothest surface was achieved when specimens were polished with Mylar strip; on the other hand, as certain authors have shown, the surface layer rich in resin has to be eliminated. However, some functional adjustment is necessary on almost all clinical restorations. The presence of surface irregularities arising from poor finishing/polishing techniques and/or instruments can affect the surface quality of composites causing plaque accumulation, [9] staining, physical properties, [10] and recurrent decay, thus affecting the clinical performance of the restoration. The increase in surface roughness of resin composites cause patients discomfort in terms of tactile perception, [11] esthetic appearance, [12] and stain resistance. [13] A clinical trial has shown that a mean roughness of 0.3 μm could be easily detected by the patients by the tip of the tongue. [11]

It is clinically important to determine the finishing technique that results in the smoothest surface with the minimum time and instruments. For years, specially designed diamonds with very fine abrasive particle size and white Arkansas stone have been used to polish resin composite restorations. However, the use of diamond burs is limited to initial contouring because of their ability to remove equal amounts of adjacent enamel (Quinz and Lentz 1996). Later, most of the emphasis was placed on the application of progressively finer grits of abrasives; the efficiency of abrasive systems is related to flexibility of the backing material, hardness of the abrasive, and how the instruments are used. [14] The abrasive particles must be relatively harder than the filler materials for the composite finishing to be effective, if not, the polishing agent will remove only the soft resin matrix leaving behind the filler particles protruding from the resin surface. [15] Various motions may be equally critical to the development of optimal surface smoothness. A rotary motion, a planar motion, and a reciprocating motion can be employed to polish the surface of resin composite. In this study, all the systems were tested using planar motion.

The size of filler particles has been used as an important parameter to characterize the restorative material for the purpose of clinical applications. Studies have shown that composites containing microfillers and nanofillers are more efficiently polished than hybrid resins. In this current study, the filler size ranged from 0.2 to 1.4 μm, and a clear relationship between filler size and composite surface roughness was observed.

In the present study, Filtek Z350XT and Te Econom showed lesser roughness compared to other resin composites, with a statistical difference of P = 0.046. The order of surface roughness ranked according to composite was Filtek Z350 < Econom < Tetric EvoCeram < Esthet XHD. The nanofill composite showed similar roughness as the microfill was not unexpected, as the nanofill composite evaluated in this study only contains particles of size below 100 nm, which is similar to the microfill composite.

In Filtek Z350, there is a combination of nonagglomerated/nonaggregated (20 nm nanosilica filler) and loosely bound agglomerated zirconia/silica nanocluster with the particle size of 5-20 nm fillers and a cluster particle size of 0.6-1.4 μm. Since this composite presents nanofillers, in this study, Filtek Supreme Plus presented a lower surface roughness than other materials after polishing. This is not in accordance with Berger et al. who reported that Filtek Supreme did not present a lower surface roughness than other microfill and hybrid composites. [16] The microfill composite (Te Econom) presents an average particle size of 0.02-0.04 μm and exhibited lower or similar surface roughness to the nanofilled composite.

The Esthet-X composite is considered to have a microhybrid and minifill filler composition and contains inorganic (bariumalumino fluoroborosilicate glass (ranging from 0.02 to 2.5 μ) with nanosized silicon dioxide particles (range 10-20 nm). The size of the filler particles may be responsible for the differences in surface roughness between Esthet and Tetric EvoCeram when polished with Pogo and Soflex. Tetric EvoCeram showed a considerably higher reduction in surface roughness after having been polished with Soflex rather than after having been polished with Pogo. This may be due to the fact that the effectiveness of the polishing systems was material-dependent.

Most of the studies have shown that flexible aluminum oxide discs are the finest instruments for providing low surface roughness on composites. [17][18][19] This study showed lower performance regarding surface roughness when finished and polished with Soflex when compared to Pogo. Studies have shown that the flexible aluminum oxide discs produce the smoothest surface due to their capability to cut the filler particle and matrix equally. Both aluminum oxide discs and diamond discs affected the surface roughness of all microhybrid and nanohybrid resin composites. The various filler particle sizes in both the microhybrid and nanohybrid resin composites exposed to the surface after polishing could explain this result.

In this study, nanofill and microfill composites showed almost similar results when polished with Soflex and Pogo. Pogo showed greater surface roughness for nanohybrid composite (Tetric EvoCeram). Soflex showed increased surface roughness for hybrid composite (Esthet XHD).

Pogo system requires polishing at two different loads; therefore, interindividual differences in relation to manual application and polishing could have greater effects on results than is the case with Soflex.

In accordance with the current results, Watanabe et al. have showed that surface finish obtained using multistep systems (Soflex) was superior than two-step systems (Pogo). [20]

Surface profilometers have been used for years to measure surface roughness in vitro investigations. Compared with optical profilometry, mechanical profilometry only gives a two-dimensional representation of the surface, which provides only little information. Here in this study, we have used optical profilometer to measure the surface roughness. The advantage of optical profilometer over mechanical is it uses beam of light to detect the tiny variations. The other advantage is it gives a quantitative aspect through the calculation of Ra and Rt.

Another important advantage is that same specimens can be reused and could be reobserved after successive time intervals. [8]

CONCLUSION

The mean surface roughness of specimens was measured with an optical profilometer. The specimens were scanned at a higher resolution with optical beam. The optical profilometer shows the three-dimensional topography of the specimens, allowing the materials to be classified according to the aspect of their surfaces.
Nanoparticle and microfill composites were significantly smoother when compared with microhybrid and nanohybrid. The effect of finishing and polishing systems on the surface roughness of composites was material-dependent. Soflex polishers were more efficient than Pogo. Soflex showed better results in nanoparticle and microfill composites.

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Conflicts of interest
There are no conflicts of interest.

References