POLISHING OF THE COMPOSITE RESIN RESTORATIONS – LITERATURE REVIEW

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Review Article

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ABSTRACT

The widespread use of aesthetic fillings has highlighted their advantages and disadvantages. One of the most troublesome features of earlier aesthetic materials was the difficulty of finishing the restoration surface to decrease adherence of food debris. The rougher the finished surface, the greater the possibility of bacterial accumulation and discolouration of restoration along the restoration margin with secondary caries formation. Aside from these clinical implications, patients are highly discerning and could detect roughness of 0.30 μm with their tongue. The aesthetic restoration should mimic the appearance of natural dentition and should have an enamel-like appearance. An increased demand for superior aesthetics from composite resin has increased the demand for more efficient and simple polishing techniques. The development of nanocomposites has given a new perspective to the polishing of composite resins. Nanocomposites claim the advantage of improved gloss, optical characteristics and reduced wear. To date, results of in vitro studies have been equivocal regarding the most efficient and effective polishing system. There is variation in the effects of different finishing and polishing instruments on the surface roughness due to great diversity in size, shape, composition and distribution of the filler particles of composite resins, type of resin and a wide variety of finishing and polishing instruments. This paper will review the different factors that affect polishing techniques used in achieving the desired polish on composite resin restorations.

Key words: finishing, polishing, surface smoothness, composite resin

INTRODUCTION

The widespread use of aesthetic fillings has highlighted their advantages and disadvantages. One of the most troublesome features of earlier aesthetic materials was the difficulty of finishing the restoration surface to decrease adherence of food debris (1). The rougher the finished surface, the greater the possibility of bacterial accumulation and discolouration of restoration along the restoration margin with secondary caries formation (2). Aside from these clinical implications, patients are highly discerning and could detect roughness of 0.30 μm with their tongue (3). The aesthetic restoration should mimic the appearance of natural dentition and should have an enamel-like appearance (4).

Plaque can accumulate on a composite surface with a roughness of 0.7μm to 1.44 μm (5, 6). It has been suggested that the threshold surface roughness for retention of bacteria is at 0.20 μm. Below this threshold no reduced bacterial retention would be expected (7). To prevent the accumulation of plaque and stain pigmentation from food, a finished composite resin surface should be highly polished and very smooth (6,8-13). Finishing involves gross reduction and contouring to obtain the desired anatomy. Polishing, on the other hand, reduces the scratches and roughness created during the finishing process (14). Smoother, better polished restorations are more aesthetic and more easily maintained leading to increased patient satisfaction and longer lasting restorations (15). The finishing and polishing procedure should be considered and planned as a conclusion and not as an option at the moment the filling is inserted in the proposed cavity (16).

The surface of light-cured composite resin is often sticky or tacky after polymerisation, unless covered with a mylar strip or some other type of agent. The atmospheric oxygen partially interferes with the curing process. A small amount of dispersed air in the unused composite resin is necessary to prevent partial curing during storage (17). The pocket of air within the composite restoration serves to inhibit polymerisation of the resin wherever there is direct contact between the air and the resin. The resin that forms a wall around the air pocket is partially inhibited from reaching its maximum curing potential (17). Oxygen also plays an important role in the optical quality, such as translucency and opacity of the resin restoration. Its presence within the composite resin restoration tends to break up or diffract light whatever the size of the restoration. Removal of the trapped air results in a more translucent restoration (17).

Curing composite resin against a mylar strip produces the smoothest surface (18-23). This surface layer is rich in resin organic binder which when in contact with oral environment discolours more than the polished surface (24). If the mylar strip is not used, polymerisation of the outer surface is inhibited resulting in sticky, soft surface. Removal of that outermost resin by trimming and finishing would tend to produce a harder, more wear resistant and an aesthetically more stable surface (23,25-27). Nancomposites have also shown superior surface smoothness when cured against a mylar strip but this surface exhibited a lower surface hardness when the surface is not finished and polished. In an experiment by Korkmaz et al. (28), the surface of Filtek Supreme XT (3M ESPE), Grandio (VOCO GmbH), Ceram X (Dentsply), Aelite Aesthetic Enamel (BISCO), Tetric EvoCeram (Ivoclar Vivadent)) and FiltekZ250 (3M ESPE) cured against a mylar strip showed lower microhardness as compared to polished surfaces of the same composite resin. In clinical practice, it is not possible to apply the mylar strip in all types of cavity fillings and almost all cavities are slightly overfilled and the excess is contoured (15, 29). A slight excess of resin prevents the possibility of an underfilled cavity and fulfils the principles of the acid etch technique for retention and aesthetic blending of the restoration with the surrounding tooth structure (30). The curing of composite resins (Tetric Evoceram, Ivoclar Vivadent; Heliomolar, Ivoclar Vivadent) against a metal matrix produced a rougher surface as compared to polished surfaces. This was not so for Tetric Ceram (Ivoclar Vivadent) (31).

An increased demand for superior aesthetics from composite resin has increased the demand for more efficient and simple polishing techniques (13). A special polishing armamentarium is needed to deal with the difficulty of polishing hard filler with a resin binder simultaneously (32). The development of nanocomposites has given a new perspective to the polishing of composite resins. Nanocomposites claim the advantage of improved gloss, optical characteristics and reduced wear (33). There is variation in the effects of different finishing instruments on the surface roughness due to great diversity in size, shape, composition and distribution of the filler particles of commercial composites, type of resin and wide variety of finishing instruments (21,34).

ABRASIVE DEVICES

Tungsten carbide burs, green carborundum stones (silicon carbide) and white arkansas stones (silicone oxide + quartz) have been used to trim conventional composite resins (25-27,35,36). After the introduction of microfilled composite resin, it became apparent that the previous commonly used burs and stones were not effective in trimming this resin system (30). Presently, the nanocomposites represent a new range of composite materials with easy polishibility and retained polish. Attempts have been made to develop finishing instruments that are suitable for all four steps of trimming procedures.

Jefferies (37) classified abrasive and finishing devices as either coated, bonded or loose abrasives. Marghalani (38) categorised them as 1) Coated disks and strips 2) Cutting carbide, diamond and stones 3) Rubberised abrasives and 4) Loose particulate abrasives in the form of polishing pastes and powders. Glazes have been introduced to improve surface finish and one has been developed specifically for nanocomposites (39).

Coated Disks and Strips

Coated abrasives are finishing devices usually in the form of a paper, mylar or some other polymeric backing. The abrasive particles are distributed and are retained on the surface of the disk material or matrix by an adhesive polymeric surface coating or layer. The most common example of coated abrasives includes circular coated finishing disks like Sof-Lex (3M Dental products division, St Paul, Minnesota) and SuperSnap finishing disks (Shofu Dental Corporation, Menlo Park, CA). Aluminium oxide particles constitute the most commonly used abrasive compound on coated abrasive disks with silicone carbide used in some commercially available products. Its ability to remove filler particles and organic matrix at the same rate has made the aluminium oxide disks an effective finishing and polishing instrument (40). Their efficiency, however, is limited by their inability to follow anatomic configurations and to reach hard to access areas of the restoration (29). Rotary diamonds have also been considered as coated abrasive devices with the cylindrical surface of the stainless steel bur mandrel acting as a carrier for the coated abrasive diamond particles.

Polyurethane based polishing and finishing disk, which are highly flexible, are widely used. These disks are coated with aluminium oxide particles (grit 150, 360, 600,1200). The aim of such polishing systems is to establish proper contour and redevelop a surface texture that would reflect light on the composite surface similar to that of enamel (32,41-43). This disk system can satisfactorily polish all surfaces except concave and interproximal surface. Best results are obtained on convex surface (44-46). Small delineated areas are not precisely finished along the gingival margins by these disks nor are they efficient in contouring cusps. Rigid rotary instruments like diamond burs, tungsten carbide burs, or stones are necessary for this purpose (47).

Kanter et al. (32) demonstrated that the smoothest surface on the composite resin restoration could be best produced by the use of series of four Sof-Lex polishing disks used sequentially from coarse (100 µm), medium (40 µm), fine (24µm) to superfine (8 µm). The grit sizes are 150, 360, 600 and 1200 respectively (30). Sidhu and Henderson (19) compared the surface finish of composite resins when finished with white stones, superfine diamond burs and aluminium oxide disks. The finished surface was measured with a profilometer and the roughness average (R_a) value was used to compare the surfaces. The aluminium oxide disks gave the best and most consistent results. Use of superfine diamond bur can produce similar Ra values but these values were highly variable. None of the methods used achieved the smoothness of composite resin cured against a mylar strip.

Stoddard and Johnson (48) evaluated the surface roughness of four anterior and four posterior composites. The polishing agents were chosen from two groups of abrasive disks or mounted abrasive points. A surface treated with mylar was used as a control. The polishing systems evaluated were Sof-Lex disks (3M ESPE), SuperSnap Rainbow (Shofu), Moore's microfill composite polishing kit, composite points (Shofu), quasite points and Vivadent polishers. The surfaces of four anterior and posterior composite resins were compared using a mylar strip, an unfilled resin as a glaze, polishing with three rubber polishers, and three different manufacturers' series of disks. They suggested that pairing a specific composite resin with a matching polishing system produced the smoothest surface. Because of the differences in the size, shape, number of filler particles, and the type of resin, one system was incapable of creating the smoothest surface for all composite resins.

Surface roughness is affected if the metal mandrel comes in contact with the surface of composite resin, thereby causing discoloration. Care should be taken to avoid contact of the mandrel with the surface of the resin (48). The metal hub of the disk can also damage the restoration. Presently, smaller metal hubs are used and some manufacturers use silicone sheaths on their disk to totally eliminate the possibility of damaging the restoration surface (49).

Polishing and Finishing Burs and Instruments

It is assumed that gentleness in handling of finishing diamond instruments at the margins of restorations has practical clinical consequences. These instruments should be used without pressure in a wiping motion under constant water spray. The continuous wiping motion is recommended to avoid formation of grooves. Restorations which are properly finished should have superior aesthetic value. They should have less opaque areas of marginal enamel, as a result of fracture, and less marginal discoloration (30). This opaque area at the enamel margin is referred to as the "white line" and will be discussed in another section.

Earlier, the use of finishing burs was absolutely contraindicated with a highspeed handpieces (26). It was believed that they operate best at 5,000 – 15,000 rpm. Presently, these burs may be used at highspeed but it was found that diamond instrument at slow speed produce less roughness than when used at high speed. This may be due to bur chatter and excessive heat generation at high speed (21). These burs are best used to finish small delineated areas and concave occlusal surfaces if used in series of 50µm – 15µm with 15µm being extra-fine followed by 25µm fine, 40µm medium and 50µm coarse (13). The use of stones and tungsten carbide burs as compared with diamond instruments has proven to be ineffective especially with microfilled composite system (23,25-27,35,50). The diamond instruments produce a very rough surface when compared with aluminium oxide polishing system (15,19,21,40,51) and abrasive impregnated disks system (15). Kaplan et al. (6) explained that the roughness is due to scratching caused by these burs on the surface of restorative materials. Hoelscher (15) recommended that the use of diamond instruments should be limited to gross finishing and contouring of restorative materials. St. Germain and Meiers (52) and Tate and Powers (53) recommended the use of aluminium oxide disks, where access is possible, following burs to obtain a clinically significant restoration surface. Jung et al. (54) demonstrated that a 30 µm diamond instrument produced greater surface roughness when used on four nanofilled and one hybrid composite resin. The same instrument produced a smooth surface when used before a tungsten carbide instrument. The surface was even smoother than that produced by Sof-Lex disks.

Comparisons of diamond instruments and tungsten carbide burs have been made. Two researches have demonstrated that the use of tungsten carbide burs is better suited for Filtek Supreme (3M ESPE) than the use of diamond instruments (54,55). In the protocol used by Jung et al., Ceram X Duo (Dentsply) had the highest surface roughness values in each polishing regimen. Other comparisons were made to compare marginal integrity when these polishing instruments were used. Maresca et al. (56) concluded that the sequential use of finishing diamonds (fine, extra-fine, ultrafine) resulted in the smallest marginal gaps in Filtek Z250 (3M ESPE) restorations on bovine teeth as compared to finishing carbides and regular-grit diamond instruments. They observed that the position of the marginal gaps was not influenced by the direction of the finishing striations.

Bonded Abrasives

Bonded abrasives are the devices in which the abrasive particles or media are uniformly dispersed throughout the device matrix. The matrix is usually an elastomeric material, such as a rubber or silicone compound, but can also be rigid and non-elastic in nature. Examples of elastomeric compounds include

Enhance polishing disks, cups and points (Dentsply) and CompoSite points, bullet and knife (Shofu). The rigid bonded abrasives are white stones found in bullet, pointed or rounded shapes used in high speed or low speed rotary handpieces. The different shapes provide for the versatility to overcome the limitation of the coated abrasives.

The most common abrasive impregnated polishing system used is Enhance polishing system (Dentsply Caulk, Milford DE) which is comprised of abrasive impregnated disks, cups and cones and two (fine 1 µm and extra-fine 0.3 µm) abrasive pastes. The cups, disks and cones are bonded type of abrasives utilised for the contouring to intermediate finishing. Abrasive devises usually contain aluminium oxide particles in a size range of 3 µm to 20 µm (37). Abrasive pastes are loose abrasive types utilised for fine finishing and polishing. Heath and Wilson (23) recommended the use of bonded abrasives for composite resin surface finishing without loose abrasives. They found that the abrasive particles preferentially remove the relatively soft resin matrix leaving the filler particles standing proud of the surface. Researchers have shown that the abrasive impregnated system produces surface rougher than aluminium oxide disks (15,57,58). This system, however, is indicated for use in polishing as it contain abrasives in disk, cup and cone forms which are accessible to most of the polishing areas unlike aluminium oxide disks which can only work well on convex and plane surfaces. Several other abrasive impregnated one-step systems are available such as PoGo (Dentsply) and Sof-Lex brush (3M ESPE). The results with PoGo have not been consistent in producing smooth surfaces in the different studies (28,39,59,60).

Loose Abrasives

Loose abrasives are polishing pastes containing a fine particle size distribution of either aluminium oxide or diamond particles dispersed in a water soluble vehicle such as glycerine. The aluminium oxide pastes are primarily designed for final polishing of composite resin material and are usually provided in two mean particle size of 1.0 µm and 0.3 µm. The diamond pastes are used for final polishing of porcelain. The use of polishing cups, however soft, is not recommended when using polishing pastes. It has been demonstrated that using the rubber cup roughens the composite resin surface (37). The rubber cup's stiffness may not allow the paste to achieve its optimum action with limited contact of the cup on the restoration surface. The use of a synthetic foam device (Enhance, Dentsply) or a synthetic felt device (SuperSnap Buff Disc, Shofu) has been proven to achieve the desired surface smoothness. The softer surface and design of these devices allows for retention, greater surface area contact and reduced spatter of the paste.

TRIMMING PROCEDURE

The surface roughness of composite resin is usually dependent on the size, hardness and amount of fillers it contains. Lutz et al. (30) have described the trimming procedure for composite resin restoration in four steps namely: 1) Gross finishing, 2) Contouring, 3) Fine finishing, 4) Polishing.

Gross Finishing

Gross finishing involves the removal of overfilling in an area where the instrument will touch the tooth structure and reduce composite resin bulk in a fast and efficient manner. This step involves use of coated or bonded abrasive materials with abrasive particle of 100 µm or larger. Diamond burs for cavity preparation are used with care to avoid contact with enamel and resin-tooth interface (23,25-27,50).

Contouring

Contouring establishes the final form of the restoration as dictated by function and aesthetics. An ideal contouring instrument should have a good cutting or grinding action without damaging the surrounding tissue or tooth structure (13). The initial contouring and removal of excess can be established using regular diamond rotary burs followed by smaller particle instruments with 40 µm diamond grit sizes (21,30) or 40 µm aluminium oxide disks (37).

Fine Finishing

Fine finishing is the final precise adjustment of the margins of the restoration by improving surface smoothness. It involves removal of scratches produced by the first two procedures. The instrument used in this case must have moderate abrasiveness and at the same time, their motion should render the surface as smooth as possible. Neither the composite material nor the enamel should be damaged during the procedure. Instruments with particle size of 25 µm and below are used.

Polishing

Polishing produces a smooth and glossy surface. Extremely fine abrasives are adequate for this purpose. They have minimal grinding effect and cause surface irregularities that are too small to be seen with visible light (23,47). Instrument particles size of 8 µm and below are used. Some systems provide loose abrasive polishing pastes for final polishing.

POLISHING MOTIONS

The type of motion employed for polishing also has an impact on achieving optimal smoothness of the composite resin system. Generally, three motions are employed for polishing aesthetic fillings (2).

Rotary (Circular) Motion

The axis of rotation is parallel to the surface being smoothened. Examples of instruments that employ this type of motion include diamond and carbide burs and cylindrical stones.

Planar Rotation

Planar rotation is described as a rotational movement. The axis of rotation of the abrasive device is perpendicular to the surface being polished. The instruments that use this type of motion are abrasive disks. Fruits et al. (2) studied the effect on surface roughness of the three abrasive motions during the polishing of amalgam (Valiant PHD, Caulk) and a resin composite (APH, Caulk). They compared the effects of equivalent abrasive grit sizes using the three different polishing motions. The rotary motion was used with the diamond instruments, planar motion with aluminium oxide disks and reciprocating motion with reciprocating handpiece. They concluded that the smoothest surface was produced when the materials were finished using the planar motion. The planar-fine combination resulted in a considerably smoother surface than did any other motion and grit combination. They suggested that it is important for the clinician to consider not only the grit size but also the motion with which the abrasive is applied.

Reciprocating Motion or Two-way Bi-directional Motion

This motion is employed with finishing strips pulled back and forth over a surface or by the tip of a reciprocating handpiece. Proximal surfaces may be polished using aluminium oxide polishing strips or diamond particle metal strips. A reciprocating handpiece with a flat abrasive paddle can be used to marginate composite resin restoration with excess at the proximal area. (49)

USE OF LIQUID POLISHER (SURFACE GLAZE/ SURFACE SEALER)

Liquid polishers or glazes are low viscosity resins used to provide gloss to improve the aesthetic quality of the restoration. This could also provide for better marginal sealing by filling in microgaps within the composite resin and against tooth structure. The use of a glaze has been shown to improve surface smoothness of polished composite resin surfaces (39). Lasting Touch (Dentsply) has been found to improve the gloss of the restoration. Biscover (Bisco) also demonstrated the ability to fill the microdefects on restoration surface and provide a uniform surface (61). The positive effects of placing liquid polish, however, may be overshadowed by the higher degree of discolouration on composite resins treated with it (62). Another disadvantage is that it does not prevent increase in surface roughness after toothbrushing (61).

COMPOSITE RESINS AND POLISHING SYSTEMS

Stoddard and Johnson (48) suggested that because of the variation in filler particle size and types of resin, it is important to pair resin composite with matching polishing system that works well with that type of composite resin. Composite resins and polishing systems from the same company have shown good surface roughness values. Filtek Supreme (3M ESPE) has been found to produce the smoothest surface when polished with Sof-Lex disks (63). Sof-Lex disks has been used in many in vitro experiments because it has consistently produced very smooth undamaged surfaces for composite resins (64). The use of Venus Supra (Heraeus Kulzer) on Venus Diamond (Heraues Kulzer) produced surface roughness below the 0.20 µm threshold at 0.039 µm.

Studies have shown that smooth surfaces produced on composite resins by polishing systems, other than that produced by the same manufacturer, has been equal to that produced by its proprietory system. A study was made to determine the effect of finishing systems on a low- shrinkage, Hermes (3M ESPE). This was polished with Enhance (Dentsply) followed by PoGo (Dentsply), Jiffy Polishing Cup (Ultradent), Sof-Lex disks (3M ESPE) followed by Sof-lex brush (3M ESPE), OptiDiscs (Kerr), OptiDiscs (Kerr) followed by Optishine brushes (Kerr) (65). This composite resin had its lowest Ra at 0.63 µm which is higher than the 0.20 µm threshold. The smoothest surface was produced by the Sof-Lex disks. Only Enhance points were not considered suitable for this composite resin.

The choice of a polishing system may be dependent on the type of composite resin used. The hybrid composite (Quadrant Universal LC, Cavex) produced higher surface roughness compared to the microhybrid (Filtek Z250, 3M ESPE) and nanohybrid (Grandio, VOCO) (61). The larger fillers in the hybrid composite could be the reason for the higher roughness values (66). Grandio, with its higher filler loading, has been found to produce higher surface roughness values compared to other nanocomposites. This has been attributed to the removal of its glass fillers (4,63,64). Its surface roughness values were below 0.02 µm (64). The apparent superior polish of Filtek Supreme (3M ESPE) has been attributed to its filler content. A nanofilled composite, it is composed of nanomer and nanocluster fillers while nanohybrids (e.g. Grandio) are hybrid resin composite resins with nanofillers in a prepolymerised filler (64). It is believed that the harder the composite resin, the rougher the surface would be (67). A contrary finding, however, was reported by Janus et al. (63). They found no correlation between roughness and filler content.

MULTI-STEP OR ONE-STEP POLISHING SYSTEM

Multistep systems were primarily recommended because the grit size of abrasives is of primary importance in finishing procedures. Systematically increasing the grit size reduces the depth and number of surface irregularities. This remains to be the most important factor in developing a well finished restoration since the surface of a restoration can be grossly trimmed, evenly contoured, finely finished and polished (2). One-step systems have been introduced to reduce clinical time and reduce the procedures performed on the composite resin. It has been observed that polishing procedures may induce damage to the composite resin (55,60). Giacomelli et al. (60) studied the surface roughness produced using multi-step (Enhance, Dentsply; Venus Supra, Haraeus Kulzer) and one-step (PoGo, Dentsply) systems on microhybrid, nanohybrid and nanofilled composite resins. The one-step PoGo system resulted in a rougher surface as compared to the unpolished control polymerised against a mylar strip. Surface roughness values for Enhance were also greater than the control but less than that for PoGo. This preliminary study used only three specimens for each test group for each composite resin. Venus Supra produced a surface comparable to the control. In another study, PoGo performed better than Super Snap (Shofu), a multi-step system (68). The manufacturer of PoGo and Enhance recommends the use of PoGo after Enhance to achieve maximal benefit of the two systems (67). This effectively converts PoGo into a multi-step system. Multistep systems have proven to be more effective than the one-step systems in several studies (51,54,60,67).

IMMEDIATE OR DELAYED POLISHING PROCEDURE

Opinions regarding the time at which polishing is commenced is equivocal. It has been demonstrated that timing of finishing procedures can affect the final outcome of surface roughness (24,69,70). The immediate polishing may affect the marginal seal as the finishing and polishing on newly polymerised composite resin may cause flow because of the thermal challenge from polishing (71). Delayed finishing and polishing procedures may allow for the post-curing polymerisation and hygroscopic expansion that improves marginal seal. On the other hand, delayed polishing may compromise the marginal seal because of stresses caused by the procedure (72). Hachiya et al. (24) found that early polishing after curing causes strains on the surface of the composite resin similar to the one produced with curing against a mylar strip. They recommended polishing of composite resin restorations at the subsequent visit. A recent study, however, demonstrated that immediate polishing resulted in similar or improved marginal sealing and surface smoothness compared to delayed polishing (two weeks storage before polishing) on a microfilled (Filtek A110) and hybrid (Filtek Z250) composite resin at three weeks and one year storage (73).

DURATION AND PRESSURE APPLIED DURING POLISHING

The amount of pressure applied is another variable which affects the results of polishing procedures. Lutz et al. (30) recommended that no pressure should be applied when polishing the composite resin restorations to avoid formation of grooves on the surface. Heintze et al. (31) reported that increasing application pressure from 2N to 4N resulted in higher surface roughness for Tetric Ceram and Tetric Evoceram (Ivoclar Vivadent) when using the Astropol polishing system (Ivoclar Vivadent). The pressure applied is not as critical when using polishing disks like Sof-Lex because of its flexibility (31). In the same study, duration of polishing had a significant effect on both surface roughness and gloss. Gloss, an optical phenomenom, results from the reflection of the incident light at an almost identical angle at which it hits the surface. Surface roughness and gloss were found to be time-dependent. For all composite resins tested, the greatest improvement in surface smoothness was seen after five seconds of polishing. In general, there was a negative correlation between surface roughness and gloss. It was suggested that gloss may be a screening procedure to determine polishibility of restorative materials.

WET AND DRY POLISHING

The effect of dry and wet polishing using Sof-Lex disks was researched by Dodge et al. (74). Dry polishing was equal to or better than wet polishing on the four composite resins tested. Silux (3M ESPE) exhibited change in colour after dry polishing. No change in hardness was detected after dry polishing. The preference for dry polishing stems from better visibility of the operative site during the procedure.

COLOUR STABILITY

Being an aesthetic restoration, the composite resin restoration must maintain its surface smoothness as well as colour. Sarac et al. (61) demonstrated differences in roughness and colour stability of a hybrid (Quadrant Universal LC, Cavex), microhybrid (Filtek Z250, 3M ESPE) and nanohybrid (Grandio, VOCO GmbH). These differences, however, were below the 3.7 threshold observable to the naked eye. The hybrid composite exhibited the highest colour change, although clinically negligible. They stated that the increase in the filler size results in surface irregularities that result in colour change. According to Lee et al. (75), the surface texture controls the amount of light reflected or scattered by teeth and dental materials. This may be the reason why the original shade is not maintained after finishing and polishing.

Reis et al. compared polished packable composite resins and a microhybrid (Filtek Z250, 3M ESPE) (76). Filtek Z250 exhibited less surface roughness and dye uptake compared to Solitaire (Haraeus-Kulzer), Alert (Jeneric-Pentron) and Surefil (Dentsply). Among the packable composites, the one with the highest roughness values did not have the highest dye uptake. It was concluded that staining was highly influenced by composite resin matrix and filler composition. A study by Ergücü et al. (77) on nanocomposites related the staining susceptibility of the materials tested to their properties rather than to the polishing system used. Urethane dimethacrylate (UDMA) has been found to be more stain resistant than BisGMA and TEGDMA. The hydrophilicity of the resin matrix may be a variable contributing to increased staining susceptibility.

Güler et al. (62) studied the colour stability of different composite resins (Filtek Z250, Filtek P60 Filtek Supreme (3M ESPE), Quadrant LC (Cavex) and Grandio (VOCO) using five polishing systems. In this study, use of polishing disks resulted in the greatest colour change while specimens polished with diamond paste had the least colour change. The authors did not mention the brand of polishing agents used except for Biscover (Bisco), also referred to as a liquid polish system. Biscover improved surface smoothness but was more susceptible to colour change. Biscover claims that its surface does not exhibit an oxygen inhibited layer. The authors postulated that a resin-rich layer (lightly filled) would make the surface more susceptible to staining. They concluded that colour stability was related to type of composite resin and polishing procedures.

THE "WHITE LINE"

The formation of the white line around restoration margins has been a source of concern for dentists. The white line appears at the margins of the restoration after finishing and polishing. This can be caused by excessive speed of the rotary instrument, high load and aggressive cutting (78). Another cause can be polymerisation shrinkage that tears the composite resin margin or tooth structure and incomplete polymerisation of the composite resin. Subsequent trapping of debris into the crevice created by the tear will result in the white line (79). Non-concentric burs and non-aggressive use of disks will help prevent this occurrence. White lines compromise aesthetics when they are situated around margins visible to an observer.

CONCLUSIONS

Based on the review of literature, the following statements on polishing of composite resins can be made:

1. The finishing and polishing procedure should be considered and planned as a conclusion and not as an option at the moment the filling is inserted in the proposed cavity.
2. Plaque can accumulate on a composite surface with a roughness of 0.7µm to 1.44 µm. The threshold smoothness is identified at 0.20 µm at which no additional reduction in bacterial accumulation would be expected.
3. Curing composite resin against a mylar strip produces the smoothest surface however this surface discolours more than the polished surface and exhibits decreased microhardness.
4. The surface roughness of composite resin is usually dependent on the size, shape, hardness and amount of fillers it contains.
5. The type of motion employed for polishing also has an impact on achieving optimal smoothness of the composite resin system.
6. Application of pressure should be avoided when polishing the composite resin restorations to avoid formation of grooves on the surface.
7. Based on in vitro studies, there is no agreement as to which polishing system would result in the smoothest surface in the different composite resin restorative materials currently used.

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