SURFACE ROUGHNESS OF DIFFERENT COMPOSITE RESIN RESTORATIVE MATERIALS

Thesis

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The present investigation is designed to study:

The effect of different finishing and polishing procedures on surface roughness of various composite resin restorative materials.

Increasing environmental concerns and public demands for esthetics have resulted to the replacement of traditional metallic restorations by more esthetic and biocompatible tooth – colored restorative materials. Composites are presently the most popular tooth – colored restorative materials, verifying esthetics. The longevity and esthetic appearance of composite restorations greatly depend on the quality of finishing and polishing techniques. Finishing is a process of removal surface defects or scratches created during the contouring process through the use of cutting or grinding instruments or both, while polishing is a process of providing luster or glossy on a material surface **(Anusavice, 2003).**

Proper finishing and polishing procedures should establish: 1) Smooth, lustrous and glossy surface that will reflecting light in a similar manner to the adjacent tooth enamel. 2) A restoration contour that is physiologically acceptable to supporting tissues , promotes periodontal health and minimizes plaque retention, surface discoloration, gingival irritation and recurrent decay **(Joniot et al., 2000 & Yap and Mok, 2002[a])**. 3) An occlusal relationship that minimizes applied stress in all functional mandibular movements. 4) Proper margin adaptation of the resin at the cavosurface margin. 5) A general contour that is in harmony with tooth form and promotes esthetics **(Criag, 1997).**

Although the smoothest surface can be achieved when the composite is cured against a celluloid matrix, unfortunately it is difficult to adjust the matrix correctly without removing the excess material. Moreover, the surface layer is essentially composed of organic matrix, which is less dense than the underlying layer. So it is recommended that the outer layer of matrix set composite restoration should be removed to expose the subsurface layer in order to obtain more abrasion resistance surface **(Joniot et al., 2000).**

The operating procedures used for finishing and polishing resin - based materials are numerous and affect the success of filling from a mechanical, biological, and esthetic point of view. Multifluted carbide finishing burs, hard-bonded/surface-coated ceramic diamond rotary instruments, impregnated rubber or silicone discs and wheels, silicon carbide-coated or aluminum oxide-coated abrasive discs, polishing pastes, soft and hard polymeric cups are among the most common finishing tools **(Jefferies, 1998 & Anusavice, 2003).**

There were several methods of measuring surface roughness, including: a qualitative SEM method, a quantitative profilometer for surface profile analysis, examined the surface by photographing it under light microscope and measuring the reflectance value of brightness from the surfaces of composite samples **(Chen et al., 1988 & Jefferies, 1998).**

So the efficacy of finishing and polishing materials and procedures on the contemporary resin-based materials is an important step within the restorative process. Therefore, it was felt that a study aiming to evaluate the effect of finishing and polishing procedures on the surface roughness of different composite resin restorative materials might be of value.

A- Restorative materials

Composites were firstly developed by Bowen in the 1960s as a filled resin material. Basically, composite restorative materials consist of a continuous polymeric or resin matrix in which inorganic filler is dispersed. This inorganic filler phase significantly enhances the physical properties of composite. Composites are usually divided into three types based primarily on the size, amount, and composition of the inorganic filler: (1) conventional composites, (2) microfilled composites, and (3) hybrid composites. In the 1970s, microfilled or polishable composite resins were introduced to replace the rough surface characteristic of conventional composites with a smooth, lustrous surface in the finished restoration. The microfilled composites contain colloidal silica particles whose average diameter ranges from (0.01- 0.04 μm), instead of containing the large filler particles of the conventional composites (5 - 8μm). Hybrid composites were introduced as a posterior restoration in 1980s. They were wear resistant because of reduced particle size and increase filler loading ranges from (0.4 - 1μm). Further refinement in these materials led to introduction of microhybrid composites with mean particle size in the range of (0.6 - 0.7μm) **(Roberson, 2002).**

The recent introduction of the packable composite has been developed to meet the long desire for esthetic direct filling materials comparable to silver amalgams in terms of durability and ease of handling. Changes developed in this new family of resin composites, include the following: 1) high filler loading and high molecular weight matrix resins, for example UDMA (Urethane dimethacrylate) and BIS-EMA (Ethoxylated bisphenol A-dimethacrylate), have lead to increased viscosity of the composite. 2) as high molecular weight resins have fewer double bonds per unit weight, they create a lower degree of cross-linking, resulting in a relatively lower level of polymerization shrinkage. 3) these materials are less sticky than traditional composite systems by slightly altering the filler content and the use of different matrix monomers. The low material stickiness reduces incorporation of air bubbles during placement and gives better durability of the restoration when placed in stress-bearing posterior regions **(Suzuki, 2001).**

Saleh et al., in 1992, studied one-year clinical evaluation of anterior microfilled composite resin (Blendax). Ninety-three class III and IV restorations were placed in vital anterior teeth. Finishing and polishing procedures were done according to the manufacturer's instructions, using Sof-Lex disk system. The surface appearance, color match, and marginal adaptation of each restoration were evaluated and recorded at baseline, 6 months, and 1 year. Randomly selected restorations were photographed and replicated for SEM observation at baseline evaluation. They concluded that, most of the restorations examined after 1 year recall remained unchanged. Changes in surface appearance, marginal adaptation, and marginal discoloration accounted for most of the changes. Most replicas of randomly selected restorations showed smooth surfaces and well-sealed margins with a smooth transition from restoration to enamel.

Cobb et al., in 2000, compared the physical properties of three packable composite resins (Alert, Surefil and Solitaire) with those of conventional hybrid composite resin (TPH Spectrum) and microfilled composite resin (Heliomolar Radiopaque) advocated for use as posterior restorative materials. They evaluated diametral tensile strength (DTS), compressive strength (CS), flexural strength (FS), and depth of cure (DC).

The results demonstrated that the greatest value for DTS and FS was for TPH Spectrum followed by Alert, Surefil, Heliomolar Radiopaque and Solitaire. Surefil had the highest CS followed by TPH spectrum, Solitaire, Alert then Heliomolar. TPH spectrum and Alert had significantly greater DC than all other resin-based composites followed, in decreasing order, by Surefil, Solitaire and Heliomolar. They concluded that, while the packable composite resins tested in this study had physical properties superior to those of the microfilled composite resin, they were no better suited for use as posterior restorative material than was the conventional hybrid composite resin. They recommended clinicians to assess the advantages and limitations of packable composite use in clinical restorative situations and to further evaluate physical properties and clinical performance of these new restorative materials.

Kelsey et al., in 2000, evaluated selected physical properties of three packable composite resins (Alert, Surefil and Solitaire) and compared them to two conventional hybrid materials (Prodigy and Z100). The specific properties investigated were diametral tensile strength, transverse strength, elastic modulus and fracture toughness. Following photopolymerization, specimens for each composite material were stored in deionized water at 37ºC for 35 days. They found that, Alert and Surefil were superior to Solitaire in the studied physical properties and comparable to the hybrid materials (prodigy and Z100).

Kinzer et al., in 2000, evaluated the clinical performance of polishable composite resin (Esthet.X) in anterior and posterior restorations. Marginal adaptation, anatomic form, color match, secondary caries, marginal discoloration and polishability were evaluated after three months. They found that, there was an increase in marginal discoloration. Restorations polished adequately showed an increase in surface polish, while restorations polished inadequately had a decrease in surface polish.

Loguercio et al., in 2001, evaluated the clinical performance of four packable composite restorative materials (Solitaire, Alert, Surefil and Filtek P60) in posterior teeth and compared with one hybrid composite (TPH Spectrum) after one year. All restorations were made using rubber dam isolation, and the cavity design was restricted to the elimination of carious tissue. In deeper cavities, they used calcium hydroxide and/or glass ionomer cement. Adhesive system and resin composite were applied according to the manufacturers' instructions, finished/polished and evaluated by two investigators then evaluated after one year. They concluded that, none of the patient complained of any symptoms, either after placement or after one year and no secondary caries.

B- Finishing and polishing procedures

The esthetics and life span of tooth-colored restorative materials is heavily dependent on the quality of surface finish as the presence of irregularities on the surface of restorative materials may influence appearance, plaque retention, surface discoloration and gingival irritation. The goal of finishing and polishing procedures is obtaining the desired anatomy, proper occlusion, and the reduction of roughness, gouges, and scratches that were produced by the contouring and finishing instruments **(Yap and Mok, 2002[a] ; and Anusavice, 2003).**

The instruments available for finishing and polishing restorations include fluted carbide burs, diamond burs, stones, coated abrasive disks, strips, polishing pastes, polymeric cups, points, and wheels impregnated with specific types and sizes of abrasive particles. The polished surface should be smooth enough to be well tolerated by oral soft tissues and to resist bacterial adhesion and excessive plaque accumulation. The most common methods used to determine the effectiveness of finishing and polishing systems on dental restoratives include: visual evaluation, SEM, and use of the profilometer to assess the mean surface roughness (Ra) of a restorative material after finishing and polishing procedures. All three methods are somewhat technique sensitive. Visual methods are prone to errors as a result of the influence of shading and the influence of the composition and structure of the specimens under evaluation. SEM must be done carefully to provide sufficient contrast to observe surface topography and to detect clearly variations in surface smoothness. Non metallic restorations need to be coated with about 200-500 Å gold layer when using SEM. When using a profilometer, several readings should be taken, surface of the specimen should be flat and presence of scratches and bubbles affect the results **(Jefferies, 1998).**

Glantz and Larsson, in 1972, compared the surface roughness of different composite resins (Adaptic, Addent 12, Blendant, Dakor, D.F.R and TD 71) to that of silicate cement (Biotrey) and polymethylmethacrylate filling material (Sevriton Simplified) before and after finishing with sand paper disks, cuttlefish disks, and aqueous suspensions of pumice. The results indicated that the brands of composite resins investigated differed in surface roughness both directly after setting and after the three different types of surface grinding used. When the composite resins as a group were compared with silicate cement, they seemed to have smoother surfaces especially when no grinding had been