# POLYCHROMATIC SUPRA-NANO FILLED COMPOSITE PROVIDING AESTHETICS AND FUNCTION ON POSTERIOR TEETH

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**ABSTRACT:**

Posterior teeth restorations present as basic requests the functional and aesthetic reconstruction of the dental element. For this, it is necessary to understand the technique and materials available to restore the tooth structure. The evolution of loading particles present in restorative materials — from macroparticles to suprananometric particles, which combine better optical and mechanical properties — allowed the professional to make very satisfactory restorations that restore shape and function really close to that present in the natural dental tissues. Thus, the aim of this study was to report a clinical case in which old composite resin restorations were replaced due to defects in shape and polish, which prejudiced the function as well. Therefore, different restoration techniques were used, resorting to a suprananometric composite resin. It is important to highlight that the evolution in the development of the composite resins has favored the control of hue, chroma and value, besides providing excellent polish and brightness.

**KEYWORDS:**

Nanoparticles. Dental polishing. Composite resins.

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## INTRODUCTION

The dental market offers great diversity of restorative materials with the purpose of realizing a restoration totally integrated to the tooth, which meets both aesthetic and functional needs.[1] Thus, knowing the behavior of dental tissues, the relationship between restorative materials with light's physical and optical phenomena,[1] as well as the teeth's anatomical details, is fundamental for the reconstruction of the dental element. Understanding the importance of observing an object and dividing it into its many dimensions is crucial to its true reproduction[2]. This is done with the teeth for example. The upper molar's crown surface is so curvilinear and sinuous that mistakes can easily occur when building the dentin and the ideal amount of enamel covering.[2] Layer stratification is necessary to compensate the intrinsic limits resulting from composites' chemistry, because there isn't, and will never exist, function without morphology, independently of aesthetics.[3] In addition, segmented stratification creates a series of densities in the restoration's interior, resulting in a mechanically effective and low contraction restoration.[3]

Doubts arise when thinking about the use of composite resins with effects or modifiers composites. Which one am I capable to use? Which will make it more natural? Which will not compromise the aesthetic result? The use of these modifiers to provide depth and naturalness to the restoration, should be well planned, considering form, location, and disposition, because it depends on personal perspectives and it is a difficult task that often fails.[3] The application of characterization materials should begin especially from the center to the margins, as subtly as possible and may be covered by the enamel layer. Another option is the use of composite resins with their own, more evident, dyes and placed in specific locations, shaded towards the predominant resin mass, as well as increments of resin mixed with certain pigments to intensify the naturalness of the restoration in certain areas.

The evolution of the composition of composites has been significant since these materials were introduced in Dentistry more than 50 years ago.[4] Initially, conventional dental composite resins had average particle sizes that exceeded 1µm, called macroparticulated, which had high strength, but were hard to polish and to give surface smoothness.

In order to meet the important long-term aesthetic need, manufacturers began to formulate microparticulated materials with particles of approximately 40 nm.[4] Despite the excellent polishing and surface smoothness of these materials, the mechanical properties of the microparticulated resins were poor due to their low amount of filler. Therefore, it was decided to associate different sizes of filler particles, resulting in the "microhybrid resin composites", with average particle sizes slightly bigger than 1µm, but also containing a portion of 40nm microparticles. Considered as a universal restorative material, these composites can be used for most anterior and posterior restorations, based on their resistance and polishing characteristics.

The most recent innovation is the development of nanoparticulated resinous materials containing only nanometric particles (1-100 nm). In addition to the purely nanometric composites, the nanohybrid resins —resulted from the incorporation of nanometric particles to the microhybrid resins— also appeared on the market.[4] For all types reported, the shape of the particles found in the different composites is irregular and/or spherical. To further improve the optical and mechanical properties of dental composites, two supra-nano filled composite resins (Estelite® Quick, Estelite Omega, Tokuyama Dental, Tokyo, Japan), both with only spherical particles, were developed based on the sol-gel method, which controls the filler particles diameter and changes the refractive rating.[5] The manufacturer's data shows that the spherical filler maintains high shining retention and provides natural-like opalescence by light diffusion and refraction.[6] This allows a superior mimicry of the restoration margins without the creation of noticeable demarcations, providing high naturalness to the restorations. In addition, manufacturers show that this resin composite allows clinicians to control the hue, chroma and value to achieve a natural effect.[5] Perez et al[5] verified with the Kubelka-Munk theory that resins with supra-nano spherical filler show greater spread and transmission when compared with other materials, because of the shape and size of the filling material. This difference must be considered in a clinical situation, to reproduce natural aesthetic restorations.

This article aims to present the replacement of restorations in posterior teeth in the four quadrants due to infiltrations, superficial roughness and lack of anatomical reproduction, which may reflect low masticatory efficiency. For this, variations of restorative technique with suprananomeric composites were used. At the same time, it is intended to evaluate clinically and follow up the restorations performed through the different techniques.

## CASE REPORT

A 29-year-old male patient sought to replace unsatisfactory composite resin restorations on the occlusal surfaces of the elements #15, 17, 24, 25, 35, 36, 37, 45, 46 and 47, and occlusal-palatal of the elements #16, 26 and 27. During the anamnesis, the patient reported no sensitivity, but said he had recently changed the amalgam restorations.

It was possible to evaluate the extension of the existing restorations in the bite-wing radiographs, so it was chosen to perform the replacements by quadrant, starting with the upper left quadrant (Fig 1).

After local anesthesia, absolute isolation of the operative field was performed to control contamination and moisture. Restorations of teeth #24, 25, 26 and 27 were removed with diamond burr # 1016 (KG Sorensen, Brazil) in high speed, under refrigeration. After complete removal of the restorative material, the edges were trimmed with a gingival margin trimmer (Fig 2).

In the tooth #26 was necessary to perform a light cured glass ionomer cement (Vitrebond, 3M ESPE, USA) lining, to protect the tooth-pulp complex (Fig 3). For adhesive bonding, selective-etching of enamel was made with 35% phosphoric acid (Ultra-Etch, Ultradent

**Figure 1:**
Initial aspect of dental elements 24 to 27.

**Figure 2:**
Aspect of the cavities immediately after removal of the restorations and regularization of the enamel edges.

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Products Inc., USA) (Fig 4) for 30 seconds, followed by rinsing and drying. The Palfique Bond self-etching adhesive system (Tokuyama Dental, Japan) was then actively applied according to the manufacturer's instructions (Fig 5) and photoactivated for 10 seconds (VALO Led, Ultradent Products Inc., USA). Increments of opaque composite resin (A2 dentin, Estelite Omega, Tokuyama Dental, Japan) were inserted into the cavity with the aid of a composite resin spatula (Fig 6) in order to reestablish the structure corresponding to the natural tooth's dentin. Subsequently, an increment of enamel resin (A2, Estelite Omega, Tokuyama Dental, Japan) was inserted and the perimeter (layout) of the cusps was delimited. The main grooves were then highlighted with the use of ocher (Ocher, Tetric Color, Ivoclar Vivadent, Liechtenstein) and brown (Brown, Kolor + Plus, Kerr Corp, USA) (Fig 7) modifiers. Finally, an effect resin (MW, Estelite Omega, Tokuyama Dental, Japan) was added, allowing reproduction of the occlusal anatomy. Each increment was photoactivated for 20 seconds and the finalization of the photopolymerization at the end of the restoration was performed using water-soluble gel (KY, Johnson & Johnson, Brazil) to inhibit contact of the last layer of unpolymerized monomers of the material with free oxygen in the environment, aiming to improve the properties of the material (Fig 8). Then the gel and the absolute isolation were removed (Fig 9).

Restorations were performed on the lower teeth (Fig 10) following the same protocol performed in the upper left quadrant (Fig 11). To diversify the techniques in the case reported, the restorations of elements #45, 46 and 47 were

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**Figure 3:**
Application of photopolymerizable glass ionomer cement to protect the tooth-pulp complex.

**Figure 4:**
Selective enamel etching with 35% phosphoric acid.

**Figure 5:**
Application of adhesive system.

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**Figure 6:**
Incremental insertion of composite resin.

**Figure 7:**
Application of colorants in the grooves region.

**Figure 8:**
Final photopolymerization with glycerin gel.

**Figure 9:**
Final aspect of dental elements 24, 25, 26 and 27.

made using the occlusal matrix technique, which proposes to make the procedure faster, to copy the anatomy with precision, and allow less or no adjustment. The patient was previously molded with the purpose of creating a wax-up of the occlusal surfaces to be restored (Fig 12) in the obtained cast model. The waxing copy (Fig 13) of the mentioned elements was done with flowable resin (Estelite flow quick, Tokuyama Dental, Japan) and polymerized together with a microapplication stick, to facilitate the adaptation and positioning of the matrices. With the field already isolated, the cavity preparation (Fig 14), the selective-etching of the enamel and the adhesive system application were performed as previously described. The composite bulk fill resin (Filtek Bulk Fill Flow, A3, 3M ESPE, USA) was inserted into elements 46 and 47 (Fig 15), filling approximately 3 mm of cavity depth, followed by photoactivation for 20 seconds. A single increment of conventional composite bulk fill resin (Filtek Bulk Fill, A3, 3M ESPE, USA) was added and the occlusal matrix was positioned (Fig 16), the excesses were removed and it was photoactivated for 20 seconds. After removing the occlusal matrix, water-soluble gel was applied and the photoactivation was supplemented for 20 seconds. The tooth #45 was restored only with the conventional bulk fill resin (Fig 17).

Finally, the upper right quadrant was restored (Fig 18). After cavity preparation, the restorative process was started by element #16, in which, due to its depth after cavity cleaning, pulp protection with photopolymerizable glass

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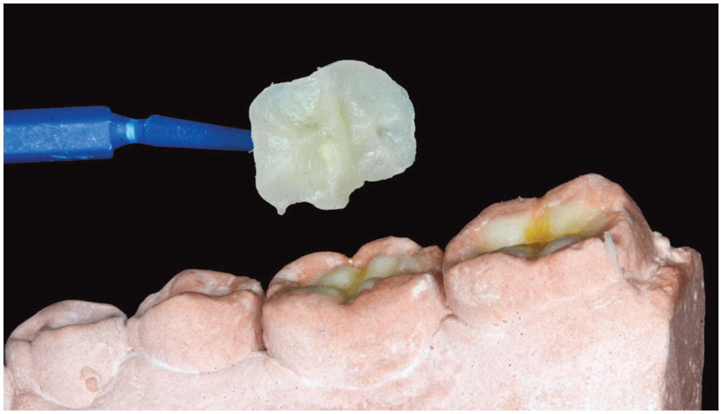

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**Figure 10:**
Initial aspects of elements 36 and 37.

**Figure 11:**
Final aspect of elements 36 and 37.

**Figure 12:**
Cast model with waxed-up occlusal surfaces.

**Figure 13:**
Occlusal matrix made from flowable resin.

**Figure 14:**
Cavity preparation of elements 46 and 47.

**Figure 15:**
Bulk fill flowable resin insertion.

**Figure 16:**
Occlusal matrix in position.

**Figure 17:**
Final aspect of the restorations.

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ionomer (Vitrebond, 3M ESPE, USA) was performed. After acid etching and adhesive application, a layer of bulk flow resin (Filtek Bulk Fill Flow, A3, 3M ESPE, USA) was used, filling 2 mm of depth and photopolymerized for 20 seconds (Fig 19). Then the composite enamel resin (A2, Estelite Omega, Tokuyama Dental, Japan) was added, following external anatomy and height of the cusps delimited by the dental element, and applying the ocher and brown modifiers, chromatizing the grooves of the occlusal surface; and white modifier (White, Tetric Color, Ivoclar Vivadent, Liechtenstein) on the cusp slopes, for greater anatomical characterization. An increment of effect resin (MW, Estelite Omega, Tokuyama Dental, Japan) was also added in the mesial surface to refine the marginal crest anatomy (Fig 20). Subsequently, element #15 was restored with the composite dentin resin (A2, Estelite Omega, Tokuyama Dental, Japan) and ocher and brown dyes to highlight the central groove. Increments of enamel composite resin (A2, Estelite Omega, Tokuyama Dental, Japan) were added and to reconstruct enamel lobes effect resin was used (MW, Estelite Omega, Tokuyama Dental, Japan). The same sequence of techniques and restorative materials of element #16 (Fig 21) were used in element #17.

Occlusal adjustment was then performed with the aid of articulating paper (Bausch, Germany), checking the contacts in maximum intercuspation and eccentric movements. After a week, the patient returned to polish the composites and

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**Figure 18:**
Initial aspects of the restorations of elements #14, 15, 16 and 17.

**Figure 19:**
Bulk Fill flowable resin insertion in element #16.

**Figure 20:**
Increase of MW effect resin for marginal crest reconstruction.

**Figure 21:**
Final aspect of dental elements #14 to #17.

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mentioned feeling better masticatory efficiency. The polishing was performed using a brush (Jiffy Brush, Ultradent Products Inc., USA), felt discs (TDV Dental Ltda., Pomerode, SC, Brazil) and aluminum oxide paste (Potenza Specchi, PHS).

## DISCUSSION

The choice of composite resins based only on optical properties, to imitate the properties of natural dental structures, does not necessarily provide a satisfactory aesthetic result[1]. In many cases, the failure results from the incorrect analysis of the optical behavior of the natural dentition as well as the inadequate use of restorative materials[1]. Therefore, it is necessary to implement a technique that allows a restorative material to be used to its full potential to correctly reproduce natural teeth.[1]

The physical understanding of the optical properties of resinous composites is mandatory for the ultimate success in dental restorations, which involves a visible combination of these properties in the restorative material and natural teeth.

The optical properties are determined by absorption and scattering of light emerging on the surface and within the environment, that are closely related to the perceived color and translucency.[7,8]

In the study by Perez et al,[5] the Kubelka-Munk theory was used to optically characterize spherical supra-nano composites and to compare them with nanoparticulate, nano-hybrid and microhybrid resins, making it clear that diffusion of light through resin composites is due to multiple refractions and reflections at the interface of resin matrix particles.

The elastic dispersion of light by spherical particles is much smaller than the wavelength of light.[5] The resin composites with supra-nano spherical filler have spherical particles with an average size of 200 nm, clearly inferior to the wavelengths of visible light. However, the spectral behavior of these dental composites (with a peak at 450 nm) is not compatible with the spectral distribution.[5] This dispersion behavior of the dental resin composites may be due to the fact that there is an incompatibility of the refractive index between the organic matrix and the filling particles as well as the size of the inorganic filling and their distribution, as suggested by some authors.[9,10] It was observed during the realization of the posterior restorations of the reported case that the composite resin used (Estelite Omega) is polychromatic, offering a complete spectrum of opacities, ideal for simpler procedures of restoration or stratified techniques, similar to the opalescence of the natural teeth.

In addition to the restorative material that more precisely matches the characteristics of natural teeth, techniques are developed to more accurately sculpt the occlusal surface. However, it is sometimes difficult to reproduce freely all occlusal topographies, such as cusps, ridges, grooves, etc.[11] In some very specific cases where the occlusal surface is almost intact at the beginning of the restorative procedure, an occlusal surface copying technique may be an interesting alternative to conventional direct techniques because it allows us to reproduce the same occlusal surface as the patient had at the beginning of the procedure.[12] In the presented case, the indirect technique with the cast study model and the wax-up was necessary to use the occlusal matrix technique, since the anatomical characteristics of the teeth had previously been compromised by the carious process and restorative procedure performed. However, the technique of sculpting and delimiting the cusp ends up favoring a better naturalness of the restorations performed, despite the unquestionable ease of the technique.

The use of the incremental technique presents some problems, such as the incorporation of bubbles or contamination between increments, difficulty in placing small layers and a prolonged treatment time. To avoid such damages, bulk fill resins were developed, which, in addition to reduced cusp deflection, also had good marginal integrity.[13] In order to evaluate the curing depth of these resins, Alrahlah et al[13] conducted a study in which different bulk fill resin composites were tested to determine their hardness profiles with Vickers Hardness Number (VHN)/depth. They obtained a depth of polymerization ranging from 4.14 to 5.03 mm, confirming the manufacturers' recommendations for the materials tested.

Bulk fill flowable composite resins are indicated because they have a lower polymerization contraction — e.g., SDR Surefil Flow (Dentsply, USA), which includes the polymerization modulator (SDR) of high molecular weight, which is chemically incorporated into the center of the monomer structure, allowing it to be used in large increments. SDR is designed to be used as a base for class I and II restorations, where its polymerization stress is reduced directly during photopolymerization, resulting in slower module development, allowing stress reduction without decreasing the conversion rate.[14] In this way, filling all cavities prepared with composites at once has obvious advantages, but the drawbacks are also apparent.[15] The potential advantages of single-fill composites are: fewer gaps in the material, since everything is placed at the same time; the technique would be quicker than several increments, if the polymerization times were identical; it may be easier than putting several increments.[15] The potential drawbacks are: more gaps may be present in the mass of the material, as it may be difficult to control the placement of the mass; making suitable contact areas can be challenging unless appropriate matrices are used; the effects of stress contraction can be more pronounced when filled over the recommended setting than when placed in increments, since the whole mass polymerizes at once, rather than small increments; the polymerization of the resin at deep preparation sites may be inadequate.[15] Thus, allying the technique of occlusal matrix with bulk fill resin, to make easier to reproduce details of the occlusal anatomy was practiced in some of the restorations of the present report. However, bulk fill resin coating the supra-nanometric resin favored a greater naturalness of the final occlusal anatomy. Clinical studies are required to verify the longevity of restorations performed this way. It should also be considered that one of the main difficulties in sculpting resins is the fact that some materials are very sticky, adhering to the spatulas, limiting the restoration of shape and anatomical contour of the tooth.[16] The viscosity of a composite resin is related to its monomer composition. The main constituent monomer of the composite resins is BisGMA[17] which provides high viscosity to the material. However, to facilitate the handling of the material and to increase its degree of conversion, other monomers are added to the composition, for example TEGDMA, which decreases the viscosity of the resinous compound. In this way, one should choose a composite that has balance in its composition and presents ideal viscosity to help the sculpting process. The choice of restorative technique will be according to the skill and preference of the professional. In the presented cases, the conventional sculpting and occlusal surface copying techniques were applied. The occlusal matrix's technique offers the advantage of allowing the incremental insertion of the composite resin in the layers that precede the placement of the matrix, minimizing the deleterious effects arising from the tensions generated during the polymerization. The pressure made by the matrix in position avoids the incorporation of micrometric bubbles inside the resin, considerably improving surface smoothness. The disadvantage of using flowable composite to make the matrix is in the cost of this material. Finally, the finishing quality of the restoration has a remarkable improvement with this technique, which minimizes the use of rotatory instruments, reducing, consequently, possible damages to the remaining dental structure and restoration.[18]

## CONCLUSION

Currently, the dental surgeon has a range of restorative materials and techniques to reach an extremely satisfactory result with direct composites restorations. Based on the presented case, it is possible to conclude that with the advance of these resins, either with incremental technique or with the use of bulk fill composites, the clinical results are similar, although the direct restorations with suprananometric ones, using the incremental technique, have a superior aesthetic aspect, due to its particles' unique characteristics.

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.