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Research Article

A Comparative Evaluation of Marginal Adaptability of Three Recent Nano-Filled Restorative Materials Under Scanning Electron Microscope-an-In-Vitro Study

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Abstract

Introduction: There have been rapid changes and developments in materials and techniques used in dentistry over the past decade than in the previous hundred years combined, and the pace is accelerating in every day. Nanocomposites are very promising new class of composites that exhibit adequate combination of chemical, physical and mechanical properties. Hence this present study was designed to compare the marginal adaptability using different recent nano-filled restorative materials under Scanning Electron Microscope in class v cavity.

Aim: To evaluate and compare the marginal adaptability of three recent nano filled restorative materials under scanning electron microscope.

Material and Method: For this study extracted 45 premolar teeth were selected. In each group, class V cavities of standard dimension (W = 1.5 H = 2.0 L = 3.0) was prepared with diamond burs and restored with the respective nanocomposites, according to manufacturer's instructions. Marginal adaptation was evaluated under scanning electron microscope and the results thus obtained was statistically analysed for comparisons among the groups.

Result: The marginal gap at interface of Group 1 and Group 2 and Group 3 ranged from 0.0 - 7.8, 0.0 - 4.2 and 0.0 - 2.3 respectively with mean (± SE) 3.42 ± 0.79, 1.61 ± 0.37 and 0.73 ± 0.20 respectively and median 2.0 and 0.7 respectively.

Conclusion: Within the limitations of the methodology used in present *in vitro* study the marginal adaptability of three recent nano filled restorative materials under scanning electron microscope it can be concluded that marginal gaps in class V cavity were maximum in brilliant flo and minimum in G-aenial Flo.

Keywords: *Nanocomposite; Class V; Marginal Adaptability*

Introduction

There have been rapid changes and developments in materials and techniques used in dentistry over the past decade than in the previous hundred years combined and the pace is accelerating in every day. Dental caries is one of the most prevalent chronic diseases in human

population worldwide, individuals are susceptible to this disease throughout their lifetime.

The mechanical interlocking between enamel and dentin in the cervical region is weaker than in other regions of the dentinoenamel junction, resulting in a higher susceptibility to crack formation. This type of cervical defect has been characterized as abfraction. Sensitivity associated with deep or caries-affected class V defects need to be restored to stop further destruction of the tooth and to avoid the risk of pulp inflammation [1].

Nanocomposites are very promising new class of composites that exhibit adequate combination of chemical, physical and mechanical properties. Only small amounts of nanofiller are sufficient to raise the values of chemomechanical properties and clinical parameters. Flowable composites are widely used in clinical practice and are the most common resin materials that are recommend for restoration of cervical lesions instead of conventional resin composites. These materials have good aesthetic properties and because of low viscosity, are easier to place and more self-adaptable compared to stiffer restorative materials. Also, flowable materials may act as a stress-breaker; therefore, they have also been advocated as a gingival liner in proximal surface composite resin restorations.

Marginal gap measurement has been defined as vertical marginal discrepancy, horizontal marginal discrepancy, overextended margin, under extended margin, seating discrepancy and absolute marginal discrepancy.

Hence this present study was designed to compare the marginal adaptability using different recent nano-filled restorative materials under Scanning Electron Microscope in class v cavity.

Aim of the Study

To evaluate and compare the marginal adaptability of three recent nano filled restorative materials under scanning electron microscope.

Materials and Methods

Armamentarium used during the study

For sample collection:

1. Tweezer (API Germany)
2. Cotton.

For sample storage and cleaning

1. Glass jar (Boroseal)
2. Saline 0.9% w/v (Nirlife health care, India)
3. Ultrasonic scalers (Biosonic, coltene, Switzerland).

For cavity preparation:

1. High speed air rotor (NSK, Japan)
2. Straight Diamond Point (SS white, USA)
3. Round Diamond Point (SS white, USA)
4. Inverted cone bur (DENTSPLY, Switzerland)
5. William's Probe (API, Germany)
6. Enamel hatchet (API, Germany)
7. Discs bur (SS white, USA)
8. Straight hand piece (NSK, Japan).

For mounting of teeth

Modelling Wax (Pyrex, India).

For restoration of cavity

1. Beautifil Injectable (SHOFU) Japan
2. Gaenial universal flo (GC) Japan
3. Brilliant flow (COLTENE) Switzerland
4. Applicator tip (Dentsply, Switzerland)
5. Light cure unit (Coltene Switzerland).

For testing of marginal adaptation

Scanning electron microscope

A scanning electron microscope (SEM) of ZEISS SIGMA FE with resolution of 1 nm @ 15kV with HD and magnification -10x to 1,000,000x and it produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the sample's surface topography and composition. The electron beam is scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer.

Methodology

Sample selection

For this study extracted human permanent premolars during routine orthodontic treatment were selected randomly. Gross cleaning of all the teeth were done under running tap water and then with ultrasonic scalar unit. These specimen were checked under illumination for any crack or discontinuity and 45 samples were selected for the study.

Inclusion criteria

1. Non carious, sound and intact human maxillary premolars with normal morphology will be selected for samples.

Exclusion criteria

1. Teeth with any crack or caries.
2. Teeth with developmental anomaly.
3. Teeth with any restoration.

These 45 selected samples were stored in saline at room temperature before preparation. The selected samples were randomly divided into three groups 15 teeth each:

- Group I BRILLIANT FLO
- Group II, BEAUTIFIL INJECTABLE (nanofilled composite)
- Group III G-AENIAL UNIVERSAL FLO will be used.

In each group, class V cavities of standard dimension (W = 1.5 H = 2.0 L = 3.0) will be prepared with diamond burs and restored with the respective nanocomposites, according to manufacturer's instructions. Marginal adaptation will be evaluated under scanning electron microscope and the results thus obtained will be statistically analysed for comparisons among the groups. After preparation of the cavities dentin bonding agents were applied to each tooth and light cured according to the manufacturers instructions in each group. Then the teeth were restored in increments with nano restorative flowable materials for each group and polymerized for 60 seconds.

Result

Statistical analysis

Groups were compared by one way analysis of variance (ANOVA) and the significance of mean difference between the groups was done by Tukey's HSD (honestly significant difference) post hoc test.

Maternal used	Group name	No of samples (n = 45) (%)
Beautifil injectable	Group 1	15 (33.3)
Brillent Flo	Group 2	15 (33.3)
Gaenial flo	Group 3	15 (33.3)

Table 1: *Distribution of samples, material used and allocation of groups.*

Marginal gap at interface

The marginal gap at interface of Group 1 and Group 2 ranged from 0.0 - 4.2 and 0.0 - 2.3 respectively with mean (± SE) 1.61 ± 0.37 and 0.73 ± 0.20 respectively and median 2.0 and 0.7 respectively.

Group	Min	Max	Mean	SE	Median
Group 1	0.0	7.8	3.42	0.79	4.6
Group 2	0.0	4.2	1.61	0.37	2.0
Group 3	0.0	2.3	0.73	0.20	0.7

Table 2: *Marginal gap at interface (μm) summary statistics of two groups.*

Comparison	Mean difference	Q value	P value	95% CI (mean difference)
Group1vs Group 2	1.81	3.51	0.045	0.035 to 3.578
Group1vs Group 3	2.69	5.23	0.002	0.922 to 4.465
Group2 vs Group 3	0.89	1.72	0.450	0.885 to2.658

Table 3: *Comparison of mean marginal gap at interface (μm).*

Discussion

The present study was carried out to compare and evaluate *in vitro*, the marginal adaptability of three recent nano-filled resin restorative materials in class V restorations.

A proper marginal sealing is essential to improve the longevity of composite resin restorations. Class V cavities were chosen in this study because they remain a challenge for restorative procedures due to several factors. These cavities frequently present gingival margins in the cementum [2], consisting of an additional challenge to obtain a proper marginal sealing.

In composite restorations, stresses generated on the restoration can disrupt the bonding and lead to the formation of gaps. Thus, a proper bond of an adhesive to the dental tissue contributes to avoid marginal gap.

All composites undergo 0.6 - 1.4% volumetric shrinkage during polymerization depending on the type of composite, the rate of cure and the amount and nature of the filler. This shrinkage can result in a gap formation between the composite material and the tooth structure, particularly if the restoration margin is placed in the dentine or cementum [3].

Marginal breakdown has been attributed to many factors, including differences in the coefficients of thermal expansion between the tooth structure and the restorative material, inadequate adhesion to dentine, and polymerization shrinkage of the resin material.

Microleakage is defined as the undetectable passage of bacteria, fluids, molecules or ions between the cavity walls and restorative materials. This seepage can cause hypersensitivity of restored tooth, tooth discoloration, recurrent caries, pulpal injury and accelerated deterioration of the restorative material [4]. Microleakage is truly a quantitative method that assesses the entire circumference of the tooth-restoration interface and it is non-destructive, allowing marginal qualities to be assessed before and after exposure of the specimens to thermocycling [5]. The extension of marginal gaps towards the axial wall of the class V restorations is commonly assessed by microleakage studies. The use of Scanning electron microscope provides a mean of visual observation of the adaptation of the restoration to cavity walls because of its high magnification and depth of focus and therefore, this method was preferred in the present study to evaluate the marginal adaptability of different restorative materials.

Possible reasons of good marginal integrity and adaptation could vary from specimen to specimen the results of this study demonstrate that the dynamic nature of substrate morphology is indeed an important factor and possibly the reason for adhesion defects of the restorative materials to the tooth structure. A perfect margin as seen in the SEM does not necessarily mean that tracers do not penetrate. This undesirable space or gap can be expected and frequently detected on margins of restorations [6].

Within the limitations of laboratory studies, quantitative marginal analysis by Scanning electron microscope has proven to be an exact and reliable assessment method for the evaluation of the marginal adaptation of adhesive restorations" [7]. Micro morphological Scanning electron microscope analysis of restoration margins can only determine the quality of the adhesive interface at the cavosurface margin. The quantitative marginal analysis and the assessment of microleakage provide complementary information and thus the status of the adhesive interface of a restoration can be determined most comprehensively if both evaluation methods are employed [8].

Premolars taken for the study were non-carious, non-restored, anomalous occlusal morphology was not included and were cleaned to remove debris calculus and rinsed with sodium hypochlorite to remove organic, tissue and then stored in distilled water. Standardization of the cavity preparation was done by measuring 3.0 mm x 1.5 mm x 2.0 mm.

The materials chosen in this study were beautifil injectable and brillient flow and G-aenial Flo as all of them are new restorative materials and very less studies are there on them to evaluate their clinical performance.

Statically there was a significant difference between Group 1 and Group 2 (p value 0.045) when compared to each other. High significant difference was observed between group 1 and Group 3 (p value 0.002).

G-aenial Flo< Beautifil < Brilliant Flow.

Maximum marginal gaps were observed in Group 1 (Brilliant flow, coltene) as the filler content is low (63% by wt; 42% by vol) as compared to Group 2 (67.3% by wt; 47.0% by vol) and Group 3 (69.0% by wt; 50.0% by vol). The revealer penetrated to a very little depth into the composite layer: 0.021 - 0.026 mm. The composite material correctly seals the grooves and pits. The resulting occlusal surface is slightly rough, with small air bubbles incorporated into the sealant revealed by the increased adherence of the revealer in the respective areas.

As compared to Group 1 (Brilliant flow) the marginal adaptability is more of Group 2 (beautifil injectable). In the present study Beauti Bond adhesive was used for this restorative materials. Flowability of Beautifil injectable allows for better wetting along the cavity walls, thus improving adaptation of the restorative material to the cavity walls. In addition, flowable resin composite with low elastic modulus was reported to relieve the stresses at the adhesive interfaces generated by occlusal forces since the flowable resin composite was able

to flex with the tooth Placement of low elastic modulus materials can act as "elastic buffers" since they have sufficient flexibility to resist polymerization shrinkage stress and favourably dissipate stresses produced by thermal variations, water absorption and occlusal loads across the interface. Some studies have shown an enhanced performance of composite restorations when an additional intermediate elastic layer was placed between the resin composite and dentin substrate. A better dissipation of shrinkage stresses, lower microleakage and improved marginal adaptation has already been reported. These could or might be explanation of the current results of marginal adaption, marginal discoloration, surface roughness and surface anatomy criteria with better performance of flowable material Beautifil injectable.

Conclusion

Within the limitations of the methodology used in present *in vitro* study it can be concluded that marginal gaps in class V cavity were minimum when restored with G-aenial Flo (0.0 - 2.3 µm) and maximum in case of brilliant flo (0.0 - 7.8 µm).

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