Original Article

Evaluation of Microleakage of Recent Nano-hybrid Composites in Class V Restorations: An *In Vitro* Study

Atul Jain[1], D Deepti[2], Pradeep N Tavane[3], Ashmita Singh[4], Pankaj Gupta[5], Anjali Gupta[2], Shweta Sonkusre[2]

[1]Professor and Head, Department of Conservative Dentistry and Endodontics, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India, [2]Student, Department of Conservative Dentistry and Endodontics, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India, [3]Professor, Department of Conservative Dentistry and Endodontics, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India, [4]Reader, Department of Conservative Dentistry and Endodontics, Rungta College of Dental Sciences and Research, Chhattisgarh, India, [5]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India

ABSTRACT

Introduction: Improved marginal adaptation and better bonding ability are the foremost requirements of a posterior composite. In search of providing a composite with least microleakage, this study aims to assess the ability of three Nanohybrid Composite resins (Estelite Alfa, Brilliant™ NG, Estelite Sigma Quick) to prevent microleakage in Class V resin composite restorations.

Methodology: A total of 60 Class V cavities were prepared with occlusal margin in enamel and the cervical margin in dentin and cementum of sound extracted premolars. After etching and bonding, restorations were randomly assigned to one of the three equal groups (n = 20) and were restored with nanocomposites (Estelite Alpha, Brilliant™ NG, Estelite Sigma Quick), respectively. Specimens were thermocycled, immersed in Methylene blue dye, sectioned longitudinally, and analyzed for leakage at the occlusal and cervical interfaces. Kruskal–Wallis test, followed by Dunn's *post hoc* Test was used to determine the intergroup and intragroup difference and Mann–Whitney *U* test was used to determine the significant difference at enamel and cementum margin.

Results: On statistically analyzing the data obtained, the mean microleakage of Estelite Sigma Quick (0.5) showed a better results followed by Estelite Alpha (0.75) and Brilliant™ NG (1.2) in enamel margin whereas, the mean microleakage in the cemental margins showed no significant difference in the mean microleakage between Brilliant™ NG (1.5) and Estelite Alfa (1.4) with least mean microleakage with Estelite Sigma Quick (0.95).

Conclusion: Based on these results, it was concluded that Estelite Sigma Quick was better than the other two nano-hybrid composites in reducing the microleakage and the cemental margins showed greater microleakage than the enamel margins. However, further studies are required to confirm the results.

Keywords: Acid etching, Cementum, Composite resin, Dental restoration, Dentin, Enamel, Nano-hybrid

Corresponding Author: Dr. D Deepti, Department of Conservative Dentistry and Endodontics, Rungta College of Dental Sciences and Research, Kohka - Kurud Road, Bhilai - 490 024, Chhattisgarh, India. E-mail: deeptisadasivuni@gmail.com

INTRODUCTION

Esthetics has become the prime requirement in the current world. From the perspective of dental restorations, along with providing esthetics, strong bonding is also a concern. Longevity of any restoration defines its clinical success. Although marginal adaptation has been enhanced with acid etching, but contraction gaps still prevail in the marginal area. This is due to polymerization shrinkage of the resin composites. In an attempt to minimize the undesirable effects of polymerization shrinkage and gap formation, numerous adhesive systems with restorations and varying placement techniques have been introduced. Nevertheless, all materials leak to some degree on dentin and cementum, and complete elimination of

microleakage at the gingival margins of composite restorations is not possible.[1]

Esthetic demands and improvements in the mechanical characteristics helped composite to be used as a posterior restoration as well. The reduction in the filler particle size, introduction of promising bonding and curing systems are contributing factors for its advancement. Composite resin materials have progressed from macro filled to micro filled restoratives and from hybrids to micro-hybrids, and the introduction of new materials such as packable, flowable, and nano filled composites into the dental market. Each type of composite resin has its own advantages and limitations.

The universal hybrid composite provides the best general blend of good material properties and clinical performance for routine anterior and posterior restorations. A new group of composite resins called nano filled composites are introduced, which uses nanofiller technology and are formulated with nanomer and nanocluster filler particles. Nanomers are discrete nano agglomerated particles of 20-75 nm in size, and nanoclusters are loosely bound agglomerates of nano-sized particles. The combination of nanomer-sized particle and nanocluster formulations reduce the interstitial spacing of the filler particles and, therefore, provide increased filler loading, better physical properties, and improved polish retention.[2]

Brilliant NG, a universal composite which has pre-polymerized particle filling, in addition to high nanometric particle content that produces a noticeable decrease in shrinkage and easily achievable high gloss surfaces. Estelite group is supra nano monodispersive spherical particle composite with Estelite Alpha being launched recently. The spherical filler particles are uniformly dispersed and manufactured by the sol-gel method. Estelite sigma quick along with supra nanoparticles also has a special Radical Amplified Photopolymerization initiator (RAP technology).[3]

It is hypothesized that there is no difference in ability to prevent microleakage among the nano-hybrid composites, i.e., Brilliant NG, Estelite Alpha, and Estelite Sigma Quick in Class V restorations.

This study aims to assess the ability of the above mentioned recent nano-hybrid composite resins in preventing microleakage for Class V resin composite restorations and to compare the efficacy of these composite resins in both enamel as well as cemental margins.

METHODOLOGY

This is a comparative study being carried out for 10 days from the time of collection to the time of completion of the methodology. Acceptance was taken from the patients prior to the extraction of their teeth.

A total of 60 freshly extracted, noncarious, unrestored human permanent premolars were collected from the Department of Oral and Maxillofacial Surgery, Rungta College of Dental Sciences and Research, Bhilai, India.

For the collected teeth following criteria were considered:

Inclusion Criteria

- Intact permanent teeth extracted for orthodontic/ periodontal reasons
- Teeth with fully formed root.

Exclusion Criteria

- Teeth with cervical abrasion and erosion
- Teeth with fracture lines
- Discolored or restored teeth
- Teeth with caries
- Teeth with developmental defects.

These specimens were collected, stored, disinfected, and handled as per the recommendations and guidelines laid by OSHA and CDC. These specimens were stored in 2.5% sodium hypochlorite for 3 days. The teeth were carefully cleaned with a hand scaler and water-pumice slurry with dental prophylactic cups to remove the deposits. The teeth were rinsed and dried to remove the remnant debris.

Cavity Preparation

After rinsing and drying, Class V cavities were prepared for each tooth with the occlusal margin in enamel and gingival margin in cementum. All the preparations were centered on CEJ and each cavity had the following dimensions: 5 mm buccolingual width, 3 mm Occluso-gingival height, and 2 mm axial depth. A 45° bevel of 0.5-1 mm width was placed on the margins.

Restoration

All the samples were divided into three groups (n = 20). Each specimen was restored with the following bonding agent and the composite according to the manufacturer's instructions

Group 1: Restoration with Brilliant™ NG (ColteneWhaledent): The cavity was etched with Coltène Etchant Gel S (35% phosphoric acid), followed by One Coat Bond SL (ColtèneWhaledent) and restored with Brilliant™ NG Composite restoration.

Group 2: Restoration with Estelite Alpha (Tokuyama): The cavity of each specimen was restored using Bond Force

bonding agent (Tokuyama), followed by placement of Estelite Alpha.

Group 3: Restoration with Estelite Sigma Quick (Tokuyama): Each specimen was treated with a single component, light cured, self-etching dental adhesive, Bond Force (Tokuyama), and the cavity was restored with Estelite Sigma Quick Composite resin.

Thermocycling

These specimens were submitted to a thermocycling regimen of 500 cycles between 5°C and 55°C water baths with a dwell time of 1 min and transfer time between baths of 3 s.

Determination of Marginal Leakage

After thermocycling, these teeth were dried superficially and the root apices sealed with modeling wax and all the teeth were entirely covered (including the apical region) with two coats of nail varnish, except for a 1 mm window around restoration margins to prevent the other surfaces from dye penetration.

The specimens were immersed in methylene blue dye for 24 h at 37°C. After staining, the teeth were rinsed. Teeth were sectioned buccolingually in the approximate center of the restoration with a double sided diamond disc.[4]

Microleakage was further assessed for both enamel and cementum margins of restorations using a Stereomicroscope by an uninvolved examiner, who had no knowledge about the materials used and assessment was done according to the scale given underneath.

The depth of the stain (dye leakage) was judged according to the following scale:
0: No dye leakage
1: Dye penetration less than half of the cavity preparation
2: Dye penetration more than half up to full cavity depth.

A non-parametric Analysis of Variance test (Kruskal–Wallis) was used to determine the significant differences among the groups, followed by Dunn's *post-hoc* Test and Mann–Whitney *U* test was used to determine the significant difference at enamel and cementum margin (Tables 1 and 2).

RESULTS

The acquired data were evaluated on the basis of the scoring criteria to assess the bonding ability of these nanocomposites in both enamel and cemental margins. As the restoration was done in the Class V cavities, the microleakage was compared between both enamel and cemental margins of all the restorations. The comparison of the mean percentage leakage at the enamel and cemental margins of the restoration among all the groups showed statistically significant results among Estelite Sigma Quick and Brilliant™ NG; however, experimentally significant values with least leakage at both enamel and cemental margins were obtained by Estelite Sigma Quick (Tables 1 and 2).

Estelite Sigma Quick showed a better bonding with minimal microleakage followed by Estelite Alpha and Brilliant™ NG group. While comparing between the groups, the mean microleakage between Brilliant™ NG and Estelite Sigma Quick showed significant difference than the other combinations (Tables 3 and 4).

Table 1: Microleakage distribution at the enamel margin (descriptive statistics)

Groups	Score			Mean±SD
	0	1	2	
Brilliant™ NG	4	8	8	1.2±0.76
Estelite Alfa	8	9	3	0.75±0.71
Estelite Sigma Quick	12	6	2	0.5±0.68

SD: Standard deviation

Table 2: Microleakage distribution at the cementum margin (descriptive statistics)

Groups	Score			Mean±SD
	0	1	2	
Brilliant™ NG	1	10	9	1.4±0.59
Estelite Alfa	1	12	7	1.3±0.57
Estelite Sigma Quick	6	9	5	0.95±0.75

SD: Standard deviation

Table 3: Intragroup comparison of the microleakage score at Enamel (Kruskal-Wallis Test and Dunns correction)

Groups	Mean difference	SE	*P* value
Brilliant™ NG			
Estelite Alfa	0.45	0.22	0.55
Estelite Sigma Quick	0.70	0.22	0.003*
Estelite Alfa			
Estelite Sigma Quick	0.25	0.22	0.28

SE: Standard error

Table 4: Intragroup comparison of the microleakage score at cementum (Kruskal-Wallis test and Dunns correction)

Groups	Mean difference	SE	*P* value
Brilliant™ NG			
Estelite Alfa	0.10	0.20	0.62
Estelite Sigma Quick	0.45	0.20	0.03*
Estelite Alfa			
Estelite Sigma Quick	0.35	0.35	0.09

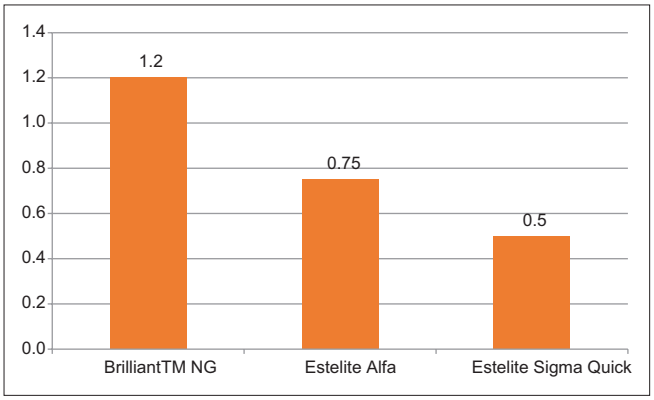
SE: Standard error

Graph 1 depicts that Brilliant™ NG showed maximum microleakage with a mean of 1.2 in the enamel margin, followed by Estelite Alfa (0.75) and Estelite Sigma Quick (0.5). Graph 2 represents the mean microleakage in the cemental margins, which no significant difference in the mean microleakage between Brilliant™ NG (1.5) and Estelite Alfa (1.4). Estelite Sigma Quick (0.95) showed least microleakage among them.

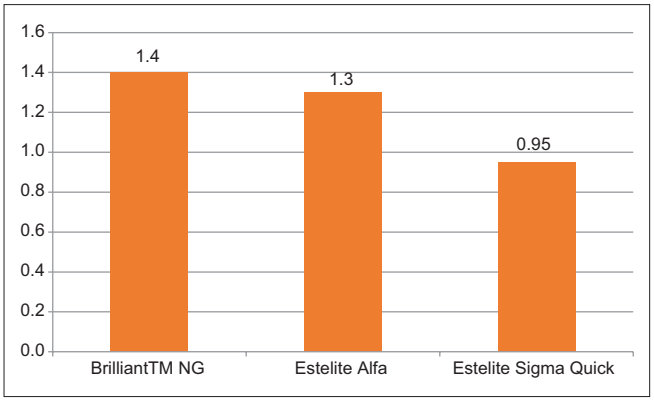
The mean microleakage of all the composites showed greater leakage in the cemental margin than enamel margin, although a significant difference was found in the margins of Estelite Alpha group (Table 5).

DISCUSSION

Microleakage is defined as dynamic clinically undetectable passage of bacteria, fluids, chemical substances, molecules and ions between the cavity walls and the restorative material applied. Microleakage is used as a measure by which clinicians and researchers can predict the performance of restorative materials in the oral environment. Polymerization shrinkage that leads to microleakage can be resisted by high bond strength between the restoration and the dentin surface thus, reducing subsequent micro gap formation at the tooth restoration interface.[2]



Graph 1: Mean microleakage at the enamel



Graph 2: Mean microleakage at cementum

Table 5: Comparison between microleakage between enamel and cementum margins (Mann-Whitney *U* test)

Group	Z value	*P* value	Significance
Brilliant™ NG	0.77	0.49	NS
Estelite Alfa	2.48	0.02*	S*
Estelite Sigma Quick	1.93	0.07	NS

S: Significance, NS: Non significance

Difference in coefficient of thermal expansion and contraction between tooth structure and the applied restorative material had been implicated in microleakage through marginal percolation or through disruption of the marginal enamel etch bond, allowing microleakage in the space resulting from thermal contraction. It has also been found that the type of occlusion and masticatory forces have a marked effect on the development of marginal leakage in composite restorations. The problems encountered with microleakage are postoperative sensitivity, marginal percolation, and secondary marginal caries.[2]

Although many composites are in the market, it is difficult to select a composite with minimal microleakage. One study stated that it is not only the degree of conversion that acts upon the polymerization shrinkage, but also the composition and structure of the material.[5] Kanika *et al.* conducted a study to evaluate microleakage of various restorative materials and concluded that nano filled composite showed least microleakage compared to other composites.[6] Ibrahim *et al.* in another study stated that among nano filled composite resins, nano-hybrid composites revealed less microleakage when compared to other composites due to their high filler content.[2]

Brilliant™ NG is a universal nano-hybrid composite with high nanometric particle content that produces optimum consistency for manipulation and less polymerization shrinkage and easily achievable high gloss surfaces.

Estelite group has supranano particles with a particle size of 0.2 µ. They were prepared by a sol-gel method, which made them uniformly spherical. They were distributed evenly in the resin matrix.

Estelite Alpha was the recently introduced nano-hybrid composite with supra-nano spherical filler particles uniformly distributed in the matrix.

This study evaluated the microleakage of Class V cavities to determine the bonding capacity of the given composites in both enamels as well as cemental area. Thermocycling was done completely according to the ideal timing.

The apical extent of the test cavities was intentionally placed into the root surface because leakage at this site

was known to be a clinical concern when Class V cavities are restored with composite resin materials.[7]

Methylene blue was used as the dye since it can diffuse easily through the interface and is easily detectable. The main advantage is that it is not absorbed by dentinal matrix apatite crystals. It also penetrates the voids better than isotopes and has low molecular weight thus has high penetrability.[8]

Brilliant™ NG is also a universal composite with pre-polymerized filler particles which further helps in reduction of polymerization shrinkage having 80% filler content by weight. Finishing and polishing also require less clinical time.

Tokuyama's Estelite Sigma Quick, has supra-nano monodispersing spherical filler particles, and is a universal composite for both anterior and posterior restorations that can also be used for esthetic situations. The unique characteristics that Estelite Sigma Quick delivers are derived from the uniform diameter, fine filler particles. Because the average particle filler size of Estelite Sigma Quick is 200 nm, it is considered a supra-nano-fill composite. It is 82% filled by weight, which allows it to have excellent strength and durability to withstand the demands of the posterior dentition and the harsh environment of the oral cavity.[3]

Estelite Alpha is a newer nano-hybrid universal material, which can be used in both anterior and posterior restorations. Its flexural strength and compressive strength are similar to Estelite Sigma Quick with a particle size of 200 nm. However, the curing time and working time of these two composites vary with each other.

The lowest leakage in this study was shown by Estelite Sigma Quick. This may be attributed to different composition and the application protocol of the manufacturer. A new technology of RAP was introduced in Estelite Sigma Quick. With the radical amplified photopolymerization initiator, the initial stage of camphoroquinone excitation by light is the same as in conventional systems. However, energy is transferred to the radical amplifier (RA); the RA is subsequently excited, then allowed to decompose to produce RA-derived radicals. Theses radicals act as the polymerization initiator and react with monomers to generate polymers, producing the curing effect. Another advantage of Estelite Sigma Quick is that it is superior at diffusing light.[3]

Many studies illustrated that the rate of volumetric polymerization shrinkage of Estelite Sigma Quick is significantly low leading to less microleakage, which support findings of the present study.[9,10] On comparison with other composite resins, the micro tensile bond strength of Estelite Sigma Quick with dentin is also good (51.0 Mpa).[11]

This study has thrown some light on the nano-hybrid composites, but still more studies are required to establish the best composite resin with least microleakage and restoration failure.

CONCLUSION

The intra-oral environmental conditions vary *in vivo* and cannot be completely simulated in an *in vitro* study.

Although this study showed Estelite Sigma Quick to be a better composite for reduction of microleakage, further studies, and clinical trials should be performed to assess the performance of these composite restorative materials before definitive conclusions are formulated.

REFERENCES

1. Ramos RP, Chinelatti MA, Chimello DT, Dibb RG. Assessing microleakage in resin composite restorations rebonded with a surface sealant and three low-viscosity resin systems. Quintessence Int 2002;33:450-6.
2. Hamouda IM, Elkader HA, Badawi MF. Microleakage of nanofilled composite resin restorative material. J Biomater Nanobiotechnol 2011;2:329-34.
3. Tokuyama Estelite Sigma Quick. Available from: http://www.dentalaegis.com/id/2012/08/tokuyama-estelitesigma-quick. [Last accessed on 2015 Mar 27].
4. Hegde MN, Vyapaka P, Shetty S. A comparative evaluation of microleakage of three different newer direct composite resins using a self-etching primer in class V cavities: An *in vitro* study. J Conserv Dent 2009;12:160-3.
5. Dupasquier F, Gritsch K, Farlay D, Zydowicz N, Grosgogeat B. Mechanical properties and polymerization shrinkage of dental nano-hybrid composites. Eur Cells Mater 2007;13:21.
6. Gupta KV, Verma P, Trivedi A. Evaluation of microleakage of various restorative materials: An *in vitro* study. J Life Sci 2011;3:29-33.
7. Shahabi S, Ebrahimpour L, Walsh LJ. Microleakage of composite resin restorations in cervical cavities prepared by Er, Cr: YSGG laser radiation. Aust Dent J 2008;53:172-5.
8. Joseph R, Singh S. Evaluation of apical sealing ability of four different sealers using centrifuging dye penetration method: An *in vitro* study. J Contemp Dent Pract 2012;13:830-3.
9. Kaga S, Fusejima F, Kumagai T, *et al*. Polymerization shrinkage ratio of various resin composites. J Dent Res 2009;88:519-23.
10. Beck P, Lindsey M, Michelson C, *et al*. Polymerization shrinkage of nine highly-filled composite materials. J Dent Res 2011;90:402-16.
11. Hirata K, Armstrong S, Qian F. Material compatibility of self-etching self-cure 1-step adhesive when dentin bonding. J Dent Res 2012;91:122.

How to cite this article: Jain A, Deepti D, Tavane PN, Singh A, Gupta P, Gupta A, Sonkusre S. Evaluation of Microleakage of Recent Nano-hybrid Composites in Class V Restorations: An *In Vitro* Study. Int J Adv Health Sci 2015;2(1):8-12.

Source of Support: Nil, **Conflict of Interest:** None declared.