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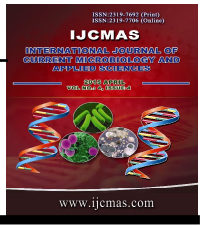


Original Research Article

Evaluation of Microleakage Between Silorane Based And Supra Nanofill Composite In Class II Cavities: An In-Vitro Study

Atul Jain[1], Shweta Sonkusre[1]*, Pradeep N Tavane[1], Asmita Singh[1], Pankaj Gupta[1], B. Gurudutt Nayak[2], Anjali Gupta[1] and D. Deepti[1]

[1]Department of Conservative Dentistry & Endodontics, Rungta College of Dental Sciences & Research, Bhilai, Durg (C.G.), India
[2]Department of Conservative Dentistry & Endodontics, KD Dental College & Hospital,Mathura, Uttar Pradesh, India
**Corresponding author*

Keywords

Cemento enamel junction, Class II Cavities, Composite, Estellite ∑ Quick, Microleakage, Silorane

A B S T R A C T

The aim of this study was to compare the microleakage in Class II box preparations with the gingival margin above and below the cemento-enamel junction (CEJ) restored with Silorane composite and Supra Nano Fill composite. Standardized box preparations (mesial box 1 mm above the CEJ and distal box 1 mm below the CEJ) were prepared in 60 mandibular premolars. The teeth were randomly divided into two groups containing 30 samples each; Group I: Restored with a Silorane composite(Filtek P90, 3M) using a horizontal layering technique, Group II: Restored with Supra Nano Fill composite(Estellite sigma quick, Tokuyama) using a horizontal layering technique. After finishing and polishing, samples were stored in distilled water for 24 hours, followed by thermocycling 500 cycles between 5^0C and 55^0C with a 30 seconds dwell time and immersion in 2% methylene blue for 24 hours. The samples were sectioned and evaluated for microleakage at the gingival margin under a stereomicroscope. Silorane composite showed less microleakage as compared to Supra nano fill composite. Also, margins with dentin cement interface had more microleakage in comparison with enamel dentin margins. Silorane composite show good results and can be better alternatives for restoring deep class II cavities.

Introduction

Posterior composites have become very popular in clinical practice due to increasing demand for esthetics and continued improvement in technology.[1,2] Handling features of these materials posses difficulty for the development of appropriate proximal contacts and contours, as it requires special wedging techniques and instruments. Direct Class II restorations provide good esthetic result at low cost but it is a challenge when margins are placed apical to cement enamel junction. [3] Any restoration that extends onto the root surface may result in less than ideal marginal integrity.

One of the major drawback of composite resin is its polymerization shrinkage. Appropriate selection of composite is very crucial especially when restoring class II restorations. Some of the desirable

properties of composite resins include smaller volumetric contraction, less polymerization shrinkage and ease of application.[4] Several types of posterior composites are available in market but still no ideal material is present.

Further research to counter polymerization shrinkage stress has led to the advent of Siloranes. In these resin matrix has been switched to a novel ring-opening monomer, which is a combination of siloxane and oxirane moieties.[5,6] Oxiranes polymerize through "cationic intermediates" in contrast to methacrylate based which polymerize through "radical intermediates". Supra nanofill (ESTELLITE ∑ QUICK) has adopted a Radical Amplified Photopolymerization technology which provides it a fast curing cycle. It has supra nano monodispersing spherical filler, giving it better esthetics and ease of handling .[7]

Several studies have been conducted comparing Silorane based composite with methacrylate composites. Though, previous studies have compared Silorane with different methacrylate based composites, but there have been no studies comparing Silorane with methacrylate based Supra nanofill composite which has a radical amplified photo polymerization technology. Thus this study was carried out to compare the microleakage in Class II box preparations with gingival margins extending coronal and apical to CEJ with Silorane based and Supra Nanofill composites.

Materials and Methods

Sixty freshly extracted intact human permanent mandibular premolars were collected from the Department of Oral & Maxillofacial Surgery. All the collected teeth were extracted for orthodontic/periodontal reasons. Teeth with caries, restoration, resorption, cervical discoloration, fracture, cervical abrasion and attrition were not included in the study. Teeth were stored in Sodium hypochlorite for 1 week and then stored in normal saline. The specimens were cleaned with pumice to remove any residual tissue tags.

Standardized class II box cavities were prepared in the teeth using a high speed water cooled handpiece with a No. 245 bur. Class II box cavities were prepared with gingival margin 1mm coronal to CEJ on mesial surface and 1mm apical to cemento-enamel junction on distal surface. The dimensions of the cavity were 3mm in the bucco-lingual dimension at occlusal, 4mm in the bucco-lingual at the gingival floor and 2mm mesio-distally. The measurements were verified with a graduated Williams periodontal probe.

A cast was developed by pouring dental stone in silicone replica of mandibular arch. The second premolar area was removed and prepared like a socket. The prepared socket was filled with high viscosity polyvinyl siloxane and a test specimen was placed in position within the template. Matrix strips and wedges were applied. Each tooth was restored in this template and then removed. Subsequently the teeth were divided into 2 groups of 30 teeth each.

GROUP 1 – Silorane system adhesive was applied according to the manufacturer's instructions. The cavity were restored with silorane composite (Filtek P90,3M;ESPE United States) incrementally (horizontal increment placement technique) and curing was done according to the manufacturer's instructions.

GROUP 2 - After etching the cavity with Conditioner 36, Prime & Bond NT was

applied. The cavity were restored with supra nanohybrid composite (Estellite ∑ Quick, Tokuyama Dental Italy) incrementally (horizontal increment placement technique) and curing was done according to the manufacturer's instructions.

After removing the matrix, all the teeth were cured from the buccal and lingual aspects and then polished. The specimens were stored for 24 hours in distilled water. Thermocycling of 500 cycles was carried out at 5 to 55 degree C, 30 second dwell time and 5 second transfer time. After thermocycling, apices of teeth were sealed with a layer of sticky wax and all tooth surfaces were covered with two coats of finger nail polish with the exception of 1mm around the tooth- restoration interface. The teeth were then immersed in 5% methylene blue dye for 24 hours.

Following immersion, the teeth were washed thoroughly with running distilled water, followed by sectioning mid-sagitally in the mesio-distal plane with a diamond disc at a slow speed. The sectioned samples were examined under a stereomicroscope to assess the extent of microleakage gingivally. Microleakage at the gingival margin was evaluated and scored under the following criteria :

0 - No dye penetration
1- Dye penetration involving half of the gingival wall
2- Dye penetration involving more than half of the gingival wall
3- Dye penetration involving the axial wall

Statistical analysis was done using Wilcoxon Signed Rank Test and Mann Whitney Test. Significance level was set at $p<0.05$.

Result and Discussion

Table I shows frequency of different score in both the groups and subgroups. Mean microleakage in Group 1 - Silorane when margins were coronal and apical to CEJ was 0.8 ±1.126 and 1.83 ±1.117 respectively. Mean microleakage in Group 2 - Supra Nanofill was found to be 1.47 ±1.137 and 2.43 ±0.935.

Table II shows intra group comparison of microleakage within two groups (Wilcoxon Signed Rank Test). Results of intra group comparison of microleakage in both the groups (Group I A – I B, $p= 0.001(p<0.05)$ &Group II A – II B $p=0.000(p<0.05)$)

Table III shows inter group comparison of microleakage between two groups (Mann Whitney Test). On inter group comparison of both the groups (Group I A – II A, $p= 0.015$ $(p<0.05)$ &Group I B – II B $p=0.022(p<0.05)$)

Composite constitute majority of the direct tooth colored restorations performed in daily clinical practice, since they replace biological tissue in both appearance and function.[8] At least half of posterior direct restoration placements now rely on composite materials. Major drawbacks of composite resins include their polymerization shrinkage, limited toughness and the presence of unreacted monomer.[9] Various methods to reduce polymerization shrinkage described in literature include using incremental placement technique during insertion & sandwich restorations. Other methods are adopting a different light curing regimen or a change in resin monomer.

Fillers present in composites influence many physical and mechanical properties of the resin. Increased filler loading reduces curing

shrinkage and also decreases coefficient of thermal expansion of composite.[10] To improve properties, the size of filler particles incorporated in the resin matrix of commercial dental composites has continuously decreased over the years, from the traditional to the supra nano fill composite materials.[11] Estelite Σ Quick has supra-nano monodispersing spherical filler particle diameters of 0.2 μm (Si-Zr). The catalyst technology adopted for Estelite Σ Quick is the Radical Amplified Photopolymerization initiator (RAP technology). As a major feature, the initiator balances the high polymerization activity needed to cure the resin with short exposure times (1/3 of that required by conventional products) and stability in ambient lighting.

Recently, researchers have made several attempts to reduce the shrinkage by changing the nature of the resin.[2] This novel resin chemistry has been synthesized from the reaction of oxiranes and siloxane molecules and termed "silorane." Concerning the material properties of siloranes, the cyclosiloxane backbone imparts hydrophobicity while the cycloaliphatic oxirane sites have high reactivity and less shrinkage (<1%) than methacrylates. [12,13,14,15]

Polymerization shrinkage is thought to be responsible for the occurrence of sensitivity and increased marginal microleakage contributing to secondary caries and thus clinically failed restoration. Estelite Σ Quick posess a Radical Amplified Photopolymerization initiator technology which is said to have polymerization activity. Siolrane based composites are claimed to have less polymerization shrinkage.

Results of intra group comparison of microleakage in both the groups (Group I A – I B, p= 0.001($p<0.05$) &Group II A – II B p=0.000($p<0.05$)) show that there is significant difference in microleakage when margins extend coronal & apical to CEJ. More amount of microleakage is seen in margins extending apical to cementoenamel junction. This can be attributed to the fact that when margins are placed in enamel dentin interphase, bonding to enamel is higher as enamel is a highly mineralized tissue, containing >90% hydroxyapatite crystals. Bonding to dentin is weak as dentin has a heterogenous structure containing 70% inorganic, 18% organic & 12% water. Also cementum has less organic phase and coarser collagen fibres rendering it a weaker bonding substrate.[16]

On inter group comparison of both the groups (Group I A – II A, p= 0.015 ($p<0.05$) &Group I B – II B p=0.022($p<0.05$)) significant difference in microleakage was found. Silorane based composite show less microleakage in comparison with Supra nanofill composite. The probable reason being that during polymerization of methacrylate based composite resin, the carbon–carbon double bond is broken by the catalyst, the monomers react with each other to form polymers, and the distance between the reacting monomers lessens as intermolecular distance of the monomer molecules in the network shortens from 0.3 nm to 0.15 nm (double bonds are polymerized to covalent main chain bonds). Although the particles retain their pre-polymerization volume, the reduced distance between the reacting monomers results in volume loss due to shrinkage.[16]

In contrast to the polymerization reaction of methacrylates, silorane based composites have ring opening polymerization mechanism. The cationic reaction is activated by a visible light photoinitiator system with camphorquinone as

photosensitizer, a tertiary aromatic amine as a photoreductant, and an iodonium salt as an electron donor that creates the active cationic species. These cationic species cause cleavage and opening of ring structure that gain space and counteract the inevitable loss of volume due to bond formation. This generates lower polymerization stress and hence less polymerization shrinkage.[16,17]

The result of this study is in agreement with the results of the previous studies which compared Silorane with different methacrylate based composites. Agrawal SV et al concluded that the use of polyethylene fiber inserts and silorane composite significantly reduces microleakage in class II resin composite restorations with gingival margins below the cemento-enamel junction compared to the methacrylate-based nanoceramic composite. Bogra P et al found that silorane-based composites exhibit much less microleakage as compared with the nanohybrid composites, probably because of the difference in the matrix system. Joseph A et al concluded that silorane-based composites showed less microleakage as compared with methacryate composite.

Table.1 Frequency of different score in both the groups and subgroups

Scores	**Group I A Above CEJ Silorane**	**Group I B Below CEJ Silorane**	**Group II A Above CEJ Estellite**	**Group II B Below CEJ Estellite**
0	18	5	7	3
1	4	6	10	0
2	4	8	5	8
3	4	11	8	9
Mean±SD	0.8 ±1.126	1.83 ±1.117	1.47 ±1.137	2.43 ±0.935

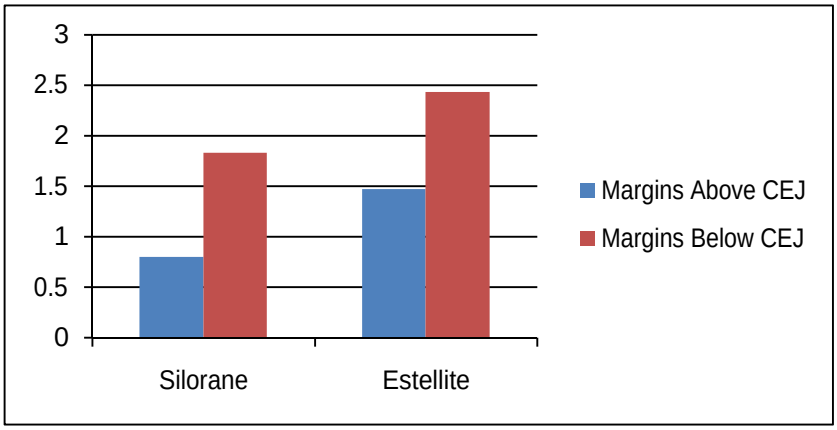
Table.2 Wilcoxon signed rank test

GROUPS	**P- VALUE**
Group I A – Group I B (Silorane)	o.oo1
Group II A–Group II B (Estellite)	0.ooo

Table.3 Mann whitney test

GROUPS	**P-VALUE**
Group I A (Silorane) – Group IIA (Estellite)	0.015
Group I B (Silorane) – Group II B(Estellite)	0.022

Graph.1 Mean microleakage in Group 1 & Group 2



In this study, methacrylate- based composite system was used with a two-step total-etch adhesive, Prime & Bond NT (priming and bonding takes place in the same step). The application of total-etch adhesives has higher technical sensitivity than self-etch systems which might have increased bonding quality and resulted in the absence of microleakage in silorane. The silorane system adhesive is essential for silorane restorative materials and is not recommended for use with methacrylate-based systems; therefore the absence of microleakage in teeth restored with silorane-based composite should not be solely attributed to adhesive; restorative systems and their adhesive systems should be considered together. Although etch-and-rinse three step formulations are still regarded as the gold standard of adhesive systems, self-etch adhesives of the latest generation have given promising results .[18,19] Earlier studies have shown that total etch and bonding has better bond strength than self etch adhesives. Though, in this study two different adhesive systems were used but the ring opening mechanism of polymerization of Silorane based composites was able to overcome the limitations associated with self etch adhesives. When comparing polymerization shrinkage, Supranano fill composite has a radical amplified photo polymerization technology (RAP) which reduces polymerization time but it does not counteract the polymerization shrinkage caused due to linear polymerization method of methacrylate based composites.

More microleakage takes place when margins were placed apical to cemento enamel junction. Silorane composite shows lower microleakage in comparison to supra nanofill composite.

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