Comparative Evaluation of Microleakage in Cavities Restored with Nanohybrid and Microfilled Composites Using Oblique Incremental Technique- An in Vitro- Study

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ABSTRACT

BACKGROUND

Many advancements have been done in the field of dentistry for resin composites applications. However, polymerization shrinkage stays a problem. Marginal gap and microleakage in between tooth cavity wall and restorative material is caused by forces of contraction, masticatory forces, polymerization shrinkage, poor adhesion, temperature variables, and inadequate moisture control. An impaired marginal seal resulting due to microleakage provides entry of oral fluids, ions, bacteria which causes recurrent caries, discoloration and hastening of marginal breakdown of restoration, hypersensitivity, pathology of pulp that would decrease the life of restoration. The purpose of restoring cavities by using nanohybrid and micro filled composite was to assess if it would eliminate or decrease microleakage in this in vitro study. We wanted to assess the effectiveness of nanohybrid and micro filled composites with regard to microleakage in class I cavity restoration.

METHODS

Standardized class I cavities were prepared over thirty teeth. The teeth samples were randomly distributed in to two groups based on composite used for restoration. Group A (n=15): Restored with nanohybrid composite followed by light curing. Group B (n =15): Restored with micro filled composite followed by light curing. The samples were stored in a 1% chloramine beta-hemihydrate solution for a day and then thermocycling procedure was performed. The samples were soaked in 2 % methylene blue for a day and sectioning of samples was done through the center of restoration using a diamond disk and analysed for methylene blue dye penetration with a stereomicroscope in 12X magnification. Scoring was done based on the criteria of a 0-4 scale.

RESULTS

Chi square test was used for performing statistical analysis. No significant difference in the microleakage score between nanohybrid and micro filled composite was seen ($p = 0.338$).

CONCLUSIONS

In this study both groups showed microleakage. However, nanohybrid composite resin showed better marginal adaptation of restoration as compared to micro filled composite resin.

KEY WORDS

Methylene Blue, Chloramine Beta-Hemihydrate Solution, Thermocycling

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BACKGROUND

The factors that influence the performance of dental restorations include the materials used for restoration, clinician's skills, the morphology and position of the teeth in the oral cavity, design and size of cavity to be restored, number of surfaces restored and age of the patient. Restorative dentistry has always aimed to achieve restorations that are biocompatible and maintain the integrity of oral cavity and tooth structure and at the same time maintain the restorative material-cavity wall interface.[1] Composite resins are used widely due to patient's high demands because they are tooth coloured restorations, devoid of mercury and bonds to teeth by use of adhesive systems and the preparation of cavity is both less invasive and less extensive. Although composites are more frequently used aesthetic restorative material it has some disadvantages. The technique of composite restoration is sensitive and consumes lot of time and it also undergoes polymerization shrinkage.[2] Microleakage is a drawback of composite that continues to be a problem.[3] It is elaborated as "a clinically undetectable movement of bacterial fluids, molecules, and ions in micro gaps (10−6 μm) between the cavity wall and the restorative material applied to it."[4] Marginal gap and microleakage in between tooth cavity wall and restorative material is caused by-forces of contraction, masticatory forces, polymerization shrinkage, poor adhesion, temperature variables, and inadequate moisture control. An impaired marginal seal resulting due to microleakage provides entry of oral fluids, ions, bacteria which causes recurrent caries, discoloration and hastening of marginal breakdown of restoration, hypersensitivity, pathology of pulp that would decrease the life of restoration.[5] The studied availability is limited comparing marginal leakage of nanohybrid composite resin and micro-filled composite resin and often give a contradictory result.

Hence, the purpose of restoring cavities by using nanohybrid and micro filled composite was to assess if it would eliminate or decrease microleakage in this in vitro study.

METHODS

After Institutional Ethical Committee approval, the study was performed in Department of Conservative dentistry and Endodontics SPDC, Wardha. The duration of study was six months. In this study 30 freshly extracted (n= 15 for each group) mandibular molar teeth were used. The samples selected were free from cracks and caries. The teeth excluded were teeth with root resorption, teeth with any fracture line, endodontically treated teeth. The samples were kept in distilled water during the period between extraction and the onset of the experiment. All 30 teeth were cleaned with an ultrasonic scaler. No. 245 carbide bur (SS White) was used to prepare thirty standardized Class I cavities on each tooth with a high-speed handpiece (NSK). The final preparations dimensions: Depth of the cavity preparation was 0.5 mm into the dentin. Etchant (37% phosphoric acid - prime dental etching gel) was applied to the cavity for 15 seconds and washed with water followed by air-drying. Bonding agent (3M ESPE, Adper, Single bond adhesive) was applied and light-curing (woodpecker) was done for 20 seconds. The teeth were randomly distributed in two groups of 15 each based on composite used for restoration using the oblique incremental technique.

Group 1: Subjected to nanohybrid composite resin material (Tetric-N –Ceram, Ivoclar Vivadent). In this nanohybrid resin was used to restore the samples obliquely such that it contacted the buccal and lingual walls after which light curing was done for 20 seconds followed by placement of successive layers obliquely and light curing for 20 seconds.

Group 2: Subjected to micro filled composite resin material (Heliomolar-RO). In this micro filled resin was used to restore the samples obliquely such that it contacted the buccal and lingual walls after which light curing was done for 20 seconds followed by placement of successive layers obliquely and light curing for 20 seconds.

The restorations were finished using diamond burs and soft flex discs (Shofu). The teeth samples were stored in a 1% Chloramine- β-Hemi hydrate solution (disinfectant) for a day and then thermocycling procedure was done in water baths (AADI) for 500 cycles for 15 seconds each at 5 ± 2 °C & 55 ± 2 °C. Apart from 2.0 mm around the restoration the samples were isolated with 2 layers of nail paint. After which the samples were soaked in 2% Methylene blue for a day and then nail paint was removed before sectioning the teeth with a diamond disk. Sectioned specimens were analysed under a stereomicroscope (ZEISS) at 12X magnification to score for the degree of dye penetration. The sectioned half having greater leakage was used for scoring and was analysed by a scoring system of 0-4 as proposed by Santosh et al for dye penetration depth.

Criteria

Score 0 (no penetration); Score 1 (penetration to 1/3 the depth of the cavity); Score 2 (penetration >1/3 but not >2/3 the depth of the cavity); Score 3 (penetration >2/3 the depth of the cavity) and Score 4 (penetration to the floor of the cavity and involvement of dentine tubules)"[(2)]

Statistical Analysis

Statistical analysis was performed using Chi-square test to assess the extent of microleakage in both nano hybrid and micro filled composite resin restoration.

RESULTS

In this study the thirty Class-I sectioned specimens were assessed under a Stereomicroscope at 12x magnification to score for degree of Methylene blue dye penetration by a scoring system proposed by Santosh et al. Data analysis was done using the Chi-square test to compare the extent of microleakage in both groups. There was no significant difference in the microleakage score between nanohybrid and micro filled composite resin with P-value = 0.338 Results are depicted in the (table 1).

Result Table						
Microleakage Score Composite Resin	**0**	**1**	**2**	**3**	**4**	**Total**
Nanohybrid Composite	8	5	2	0	0	15
Microfilled Composite	4	5	3	2	1	15
Total	**12**	**10**	**5**	**2**	**1**	**30**

Table 1. Micro Leakage Score of both the Composite Resin Groups

DISCUSSION

As the instrument is withdrawn from the cavity traditional composite tend to be pulled away and does not offer any resistance to placement forces as they tend to be sticky. This leads to incomplete adaptation of materials resulting in incomplete marginal sealing.[6] There is a higher chance of contraction of restoration with less volume of filler material and higher volumetric contraction away from the tooth surface.[7] On adding fillers into conventional composites packable composites have been developed to counter these problems which are better having reduced wear, more curing depth and higher packability. Through increased filler loading reduced polymerization shrinkage is achieved and it offers significantly decreased marginal leakage.[3] In this study nanohybrid and micro filled composite resin are used as they are routinely used in the dental practice due to its advantages like nanohybrid composite contain nanometer particles 0.005-0.01 nm combined with more conventional filler technology. Nano exhibits higher polishability while the increase particle size provides strength, easy shade selection system, fluorescence, radiopacity, translucency and also better handling.

And in micro filled composite the filler are amorphous silica particles of 0.04 mm average diameter with such small filler particles they are translucent and highly aesthetic but high filler loading is difficult to achieve. The success of cavity restored with resin composite material depends on the close adhesion of restorative material with cavity prepared.[8] Composite undergoes shrinkage during polymerization due to polymerization of monomers. The place where polymerization shrinkage is more the composite adhering to tooth creates a gap which results in microleakage formation. A pathway for bacteria, ions and oral fluids is created due to microleakage that can cause marginal discoloration.[8] Some restorative aspects are considered for excellent adhesive properties for bonded restorations.[5,9] It was stated that in better adaptation of composites the geometric cavity configuration has a major role. Many techniques have been suggested that potentially resists shrinkage of composite like soft curing, application of a liner, various cavity designs, incremental technique, application of self-cure resin before the application of first increment, increase the content of filler.[10] Class I cavity preparation has increased C factor ratio which results in increased polymerization contraction and hence was used for this study.[2] To reduce polymerization contraction with increased C-factors incremental application is used.[11]

In this study composite was restored using oblique/Z-technique. In this technique composite resin is placed in 2 mm increments such that it contacts bottom and wall of cavity prepared which shows improved results in depth of cure, strength and its density. As a result, there was reduced polymerization stress.[2,5] Different studies have shown better adaptation with the use of oblique incremental technique.[5,11-18] For the temperature change taking place in the oral cavity Thermocycling was done in this study by continuous high and low-temperature exposure to test the adhesion of the restoration.[1,2]

In laboratory experiments, thermocycling is often employed however due to changes in dentin surface after extraction and loss of dentin fluid along with changes induced by routine drinking and eating results may vary with in vivo and in vitro cases.[19,20] Roulet et al. introduced using dye solutions and qualitatively analyse in vitro microleakage assessments.[2] Dye penetration method is commonly used and therefore has been applied in this study to test microleakage.[21,22] Methylene blue has been used as it has more penetration and less molecule size (0.5–0.7 mm).[2] From the study, microleakage among micro filled and nanohybrid, are not significantly different (p-value = 0.338). This was possibly caused by a high C-factor ratio in Class 1 cavity forms. Both groups show microleakage, however, nanohybrid composite resin shows less microleakage when compared to micro filled composite resin.

Limitations

Results may differ from in-vivo studies due to the presence of dissimilar conditions. Occlusal stress due to cyclic loading can result in microleakage and failure of restoration.

CONCLUSIONS

None of these composites showed complete sealing of the cavity in terms of leakage scores. However, the use of nanohybrid composite resin showed overall less microleakage when compared with the micro filled composite resin group.

REFERENCES

[1] Sooraparaju SG, Kanumuru PK, Nujella SK, et al. A comparative evaluation of micro-leakage in class v composite restorations. Int J Dent 2014;2014:685643.
[2] Kartikasari AD, Indrawati D, Kamizar. Comparative study of resin composite class I restoration microleakage between bulk fill technique with and without sonic activation, and incremental technique. Journal of Physics: Conference Series 2017:884 :012063.
[3] Majety KK, Pujar M. In vitro evaluation of microleakage of class II packable composite resin restorations using flowable composite and resin modified glass ionomers as intermediate layers. J Conserv Dent 2011;14(4):414-7.
[4] Lokhande NA, Padmai AS, Rathore VPS, et al. Effectiveness of flow-able resin composite in reducing microleakage - an in vitro study. J Int Oral Health 2014;6(3):111-4.

[5] Baig MM, Mustafa M, Al Jeaidi ZA, et al. Microleakage evaluation in restorations using different resin composite insertion techniques and liners in preparation with high C-factor-An in vitro study. King Saud University Journal of Dental Sciences 2013;4(2):57-64.
[6] Leevailoj C, Cochran MA, Matis BA, et al. Microleakage of posterior packable resin composites with and without flowable liners. Oper Dent 2001;26(3):302-7.
[7] He Z, Shimada Y, Sadr A, et al. The effect of the cavity size and filling method on the bonding to class I cavities. J Adhes Dent 2008;10(6):447-53.
[8] Wahab FK, Shaini FJ, Morgano SJ. The effect of thermocycling on microleakage of several commercially available composite class v restorations in vitro. J Prosthet Dent 2003;90(2):168-74.
[9] Belwalkar VR, Gade J, Mankar NP. Comparison of the effect of shear bond strength with silane and other three chemical presurface treatments of a glass fiber-reinforced post on adhesion with a resin-based luting agent: an in vitro study. Contemp Clin Dent 2016;7(2):193-7.
[10] Feilzer AJ, De Gee AJ, Davidson CL. Setting stress in composite resin in relation to the configuration of the restoration. J Dent Res 1987;66(11):1636-9.
[11] Deliperi S, Bardwell DN. An alternative method to reduce polymerization shrinkage in direct posterior composite restorations. J Am Dent Assoc 2002;133(10):1387-98.
[12] Hansen EK. Effect of cavity depth and application technique on marginal adaptation of resins in dental cavities. J Dent Res 1986;65(11):1319-21.
[13] Lutz F, Krejci I, Barbakow F. Quality and durability of marginal adaptation in bonded composite restorations. Dent Mater 1991;7(2):107-13.
[14] Lopes GC, Baratieri LN, Monteiro S, et al. Effect of posterior resin composite placement technique on the resin-dentin interface formed in vivo. Quintessence Int 2004;35(2):156-61.
[15] Nadig RR, Bugalia A, Usha G, et al. Effect of four different placement technique on marginal microleakage in class II composite restorations: an in vitro study. World J Dent 2011;2(2):111-6.
[16] Poskus LT, Placido E, Cardoso PEC. Influence of adhesive system and placement technique on microleakage of resin-based composite restorations. J Ades Dent 2004;6(3):227-32.
[17] Idriss S, Habib C, Abduljabbar T, et al. Marginal adaptation of class II resin composite restorations using incremental and bulk placement techniques: an ESEM study. J Oral Rehab 2003;30(10):1000-7.
[18] Loguercio AD, Reis A, Schroeder M, et al. Polymerization shrinkage: effect of boundary conditions and filling technique of resin composite restorations. J Dent 2004;32(6):459-70.
[19] Attar N, Turgut MD, Gungor HC. The effect of flowable resin composites as gingival increments on the microleakage of posterior resin composites. Oper Dent 2004;29(2):162-7.
[20] Pashley DH. Clinical considerations of microleakage. J Endod 1990;16(2):70-7.
[21] Alani AH, Toh CG. Detection of microleakage around dental restorations: a review. Oper Dent 1997;22(4):173-85.
[22] Patni PM, Chandak M, Jain P, et al. Stereomicroscopic evaluation of sealing ability of four different root canal sealers- an invitro study. J Clin Diagn Res 2016;10(8):ZC37-9.