British Journal of Medicine & Medical Research
20(3): 1-8, 2017; Article no.BJMMR.31327
ISSN: 2231-0614, NLM ID: 101570965

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Sealing Ability of Nano Hybrid Bulk Fill Composites and High Strength Posterior Glass Ionomer Cements in Restoring Class V Lesions - A Microleakage Study

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Authors' contributions

This work was carried out in collaboration between all authors. Authors CS and AKL designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AR and AS managed the analyses of the study. Author SS managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2017/31327
Editor(s):
(1) Yoshiro Fujii, Manager of Shin Kobe Dental Clinic, Japan.
(2) Chan Shen, Department of Biostatistics, MD Anderson Cancer Center, University of Texas, USA.
Reviewers:
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Complete Peer review History: http://www.sciencedomain.org/review-history/18144

Original Research Article

Received 31st December 2016
Accepted 3rd March 2017
Published 10th March 2017

ABSTRACT

Aim: The aim of the study was to evaluate the microleakage of nano hybrid composite (Tetric N ceram- bulk fill, Ivoclar Vivident, USA) and high strength glass ionomer (GC Fuji IX, GC corporation, Tokyo, Japan) in class V restorations using a dye leakage model.
Study Design: Study design included dye penetration model and observing the samples under Stereomicroscope at 20X magnification.
Place and Duration: The study was conducted in the Department of Conservative Dentistry and Endodontics, A. B. Shetty Memorial institute of Dental Sciences, Nitte University, Deralakatte, Mangaluru, Karnataka, India over a period of 1 month.

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Materials and Methods: The study included collection of thirty molars and preparation of class V restorations in each tooth. All the teeth were randomly divided into 3 groups
Group I: Cavities left unrestored (Served as Positive control) Group II: Class V cavities restored with high strength glass ionomer (GC Fuji IX), Group III: Cavities restored with nano hybrid bulk fill composites (Tetric N ceram- bulk fill). After thermocycling, all the samples were placed in 2% methylene blue for 48 hours for cervical dye penetration test. All the samples were cut buccolingually using a diamond disk and dye leakage on cervical margin was measured under stereomicroscope at 20X magnification. All the results were subjected to statistical analysis.
Results: The Kruskal Wallis test showed significant results for microleakage between groups. Fuji IX showed better sealing compared to Tetric N ceram- bulk fill. Control group exhibited highest microleakage. Mann Whitney U test of pair wise comparison between groups showed no significant microleakage between Fuji IX and Tetric N ceram group.
Conclusion: Within the limitations of the present study, none of the materials were free from microleakage. Fuji IX Glass ionomer cements showed less dye penetration than Tetric N ceram.

Keywords: Microleakage; glass ionomer; dye penetration; nano hybrid composites.

1. INTRODUCTION

Micro leakage is the movement of bacteria, fluids, molecules or ions, and even air between the prepared cavity wall and the subsequently applied restorative materials [1]. Cervical lesions due to caries, erosion, or abrasion often appear in both enamel and dentin or cementum margins [2]. The longevity of a conventional class V restoration can be affected by mechanical, thermal, and chemical factors and result in stress at cervical areas [3].

Due to high esthetic demands of patients many esthetic restorative materials were developed. One of the major breakthrough was invention of adhesive cements which bonds to tooth structure and have good shade matching. Glass ionomer cements are most commonly used due to fluoride release and chemical bonding to tooth structure. More recently bulk fill composites are used increasingly for restoring Class V lesions, but major disadvantage is polymerization shrinkage which leads to microleakage followed by secondary caries or staining of the margins of restoration [4].

Tetric N ceram- bulk fill (Ivoclar Vivadent, USA) is a newly developed nano hybrid composite which have high filler loading along with good polishability and hence less polymerization shrinkage [5].

To overcome the disadvantages of glass ionomer cements regarding strength and wear resistance. GC Fuji IX(GC Corporation, Tokyo, Japan) was introduced to use for restoring stress bearing areas [6,7].

The aim of the present study was to evaluate the amount of microleakage of Tetric N ceram and GC Fuji IX in Class V restorations using a dye leakage model. The tested null hypothesis was that nanohybrid bulk fill composites and high strength glass ionomer cements show a similar kind of microleakage.

2. MATERIALS AND METHODS

2.1 Sample Selection Criteria

Thirty non-carious periodontally compromised human extracted permanent first and second molars were utilized in this study. The teeth were cleaned by scraping, to remove debris and stored in saline before use. The present study was designed and executed in the Department of Conservative Dentistry and Endodontics at A. B. Shetty Memorial Institute of Dental Sciences, Nitte University, Deralakatte, Mangaluru, Karnataka.

2.2 Sample Preparation

Class V cavities were prepared on the cervical surfaces of the extracted teeth. Cavities were prepared with standardized measurements of height of 2 mm, width of 4 mm, and depth of 2 mm (Fig. 1) using a high speed hand piece with air-water coolant, ISO size (No.010) straight fissured and (No.014) inverted cone diamond points [8,9]. After every five cavity preparation, bur was replaced. Dimensions of cavity were measured using a William's graduated periodontal probe to maintain uniformity. The cavity preparation was done by only one operator

to ensure consistent depth and size of cavity preparation

2.3 Restorative Procedure

The teeth were randomly divided into three experimental groups of 10 teeth in each.

Group-I: Positive control (cavities left unrestored)
Group-II: High strength Glass ionomer (GC Fuji IX)
Group-III: Nano hybrid bulk fill composite (Tetric N ceram- bulk fill)

The prepared cavities of Group – II were restored with GC Fuji IX Glass Ionomer (GC, Japan) and Group III were restored with Tetric N ceram- bulk fill (Ivoclar Vivadent) as per manufacturer's instruction. After 24 hours, the restorations were polished so that they properly merged with the tooth surface. All three group samples were stored for 24 hours in distilled water.

2.4 Thermal Cycling and Microleakage Testing

The samples were later on thermocycled for 500 cycles between 5°C ± 2°C and 55°C ± 2°C with dwell time of 30 seconds [8,10] after which the entire tooth surface was painted with two coats of water resistant varnish to within 1 mm of the restoration margins. The teeth were immersed in 2% methylene blue dye for 48 hours. Each tooth was sectioned in the bucco-lingual direction through the center of the bulk of restorations by diamond disk using a slow speed hand piece under water spray and observed under stereomicroscope at 20X magnification for dye penetration [11]. Each section image was captured using a Motic M210 camera (Fig. 2). The microscopic images of each section was observed in a computer screen with 640 x 480 resolution and the length of dye penetration was measured with Motic image plus software and dye penetration was evaluated at the tooth–restoration interface on the gingival/ cervical side of the restoration using scoring criteria suggested by Silveira de Araújo et al. [8] (Fig. 3).

0 = no dye penetration
1 = dye penetration to less than half the cavity depth (< 1 mm)
2 = dye penetration to more than half the cavity depth (1- 2 mm)
3 = dye penetration to the axial wall and beyond (> 2 mm)

All the results were statistically analyzed. Kruskal Wallis test was done to evaluate the microleakage of all the groups and Mann Whitney U test was done to evaluate the pair wise comparison between groups.

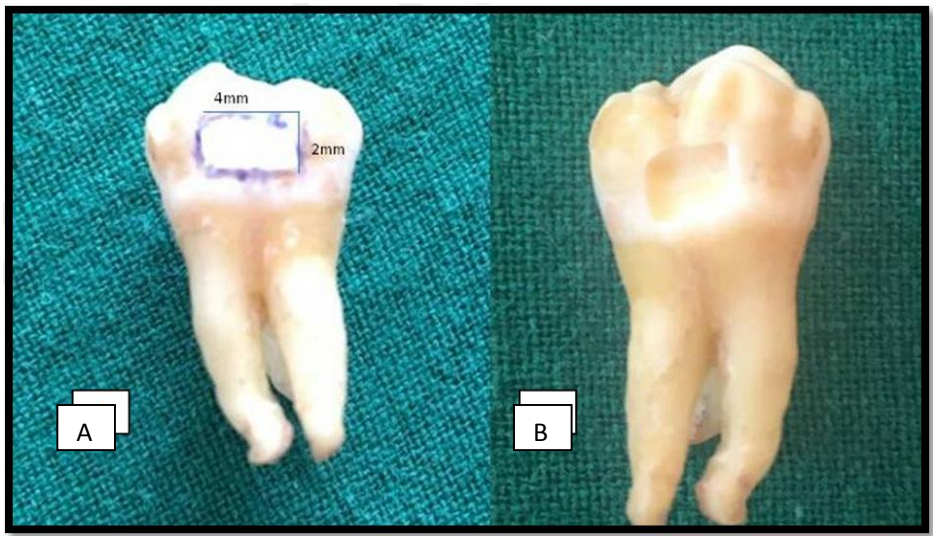

Fig. 1A. Shows a standard measurement tape of 4 mm width and 2 mm height was stuck B. Shows cavity design after cutting with standard measurements

Fig. 2. Stereomicroscope with Motic 210 camera used for the study

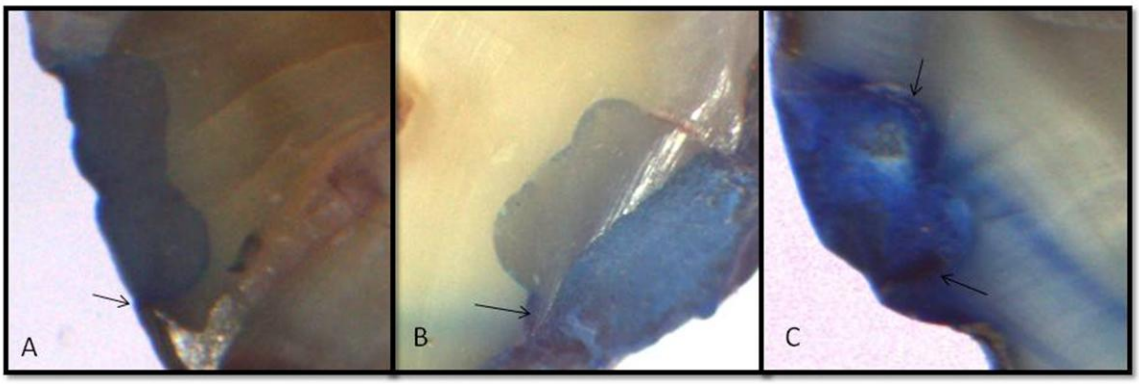

Fig. 3. Dye penetration between different groups based on scoring criteria

3. RESULTS

In the present study, Group II exhibited least microleakage followed by group III and the highest microleakage was observed in group I. Kruskal Wallis test indicated significant differences between the restorative materials for overall scores (*P* =.02) (Table 1). Further Mann Whitney U Test was undertaken for pair wise comparison (Table 2), which revealed statistically significant differences between Fuji IX glass ionomer cement and control group (*P* =.006) (Table 2). Fuji IX Glass ionomer demonstrated less dye penetration compared to group I. On comparing Fuji IX Glass ionomer cement along with the Tetric N ceram, no statistically significant difference was revealed (p=0.09) in dye penetration scores.

4. DISCUSSION

The present study was designed to evaluate the sealing properties of high strength glass ionomer (GC Fuji IX) and nano hybrid composite (Tetric N ceram) to the tooth surface. The results of the present study showed significant difference

Table 1. Comparison of microleakage between groups

Group	Sample size	Percentiles			Kruskal Wallis test	
		Q1	Median	Q3	Chi square test	P value
Group I	10	2	3	3	7.82	0.02*
Group II	10	0.75	1	2.25		
Group III	10	1.75	2.50	3		

**p<0.05 Statistically significant*

between the overall scores hence the null hypothesis that nanohybrid bulk fill composites and high strength glassionomer cements will show similar microleakage was rejected.

Table 2. Pair wise comparison between groups

Mann Whitney U test		
Group I vs Group II	Group I vs Group III	Group II vs Group III
0.006*	0.26	0.09

**p<0.05 Statistically significant*

Glass ionomers exhibit the advantages of chemical bonding to the tooth structure and fluoride release, but presents less wear resistance. High strength glass ionomers show superior wear resistance and high strength compared to metal reinforced glass ionomers and is commonly used in atraumatic restorative technique [9].

Bulk fill composites ideally should have less polymerization shrinkage on bulk placement with cavities with high C factor. Tetric N ceram bulk fill, nano optimized 4 mm composites were developed for bulk placement of upto 4mm without any adverse effects of polymerization shrinkage.

Thermocycling is the most commonly employed method for testing adhesive materials. The tooth restoration interface is subjected to extreme temperature changes which almost resembles the temperature changes in oral cavity. This results in uneven thermal expansion of tooth and restorative material which leads to failure of adhesive joint and microleakage [12]. Wahab et al. in their study concluded that thermocycling significantly increased the microleakage in class V restorations [13]. Hence in the present study, thermocycling was performed.

Dye penetration is one of the commonest method used to evaluate the sealing ability of materials. The use of dyes is one of the most common and traditional method employed to study microleakage. Hence present study was conducted based on dye penetration methodology. It is stated that dyes are cheap, simple, safe and easier to handle than radioisotopes. In the present study methylene blue dye was used to evaluate microleakage depth penetration. Various dyes have been used in microleakage studies like aniline dye, Prussian blue dye, Procion B blue dye, Indian ink, eosin, crystal violet dye etc. But Methylene blue dye is one of the most popular dye solution. Stewart for the first time used methylene blue dye in the year 1958 [14,15].

Cervical lesions often have margins extending into dentin and sometimes subgingivally on to the cementum. This makes the resin adhesion difficult in cases of class V restorations where moisture control is a difficult task making these materials technique sensitive and glass ionomers are water based cements showing superior bonding because of chemical bonding to tooth structure but they also show moisture sensitivity until the materials sets. Poggio et al showed no incisal leakage compared to cervical lekage in class V restorations [16]. The present study included only cervical microleakage evaluation due to high rate of failures seen on the cervical aspect of the restorations [17,12].

Kermanshah et al conducted a study on effects of cyclic loading on microleakage and concluded that there was no effect of cyclic loading on increase of microleakage. Hence cyclic loading was not included in the present study. He also stated that properties of restorative materials are most important in resistance to microleakage, low shrinkage composites produce low polymerization stress hence can withstand fatigue at the interface [18]. In the present study we have included that nanohybrid composites show less polymerization shrinkage and have higher fatigue limits, where as glass ionomer cements due to chemical bonding to tooth structure have the ability to flex along with the tooth.

In our present study, the Group I exhibits maximum micro leakage than any other groups; indicating that there is considerable amount of micro leakage which happens within the dentine. It is an indication to decide the better restorative materials for the suitable durable restoration.

In comparison between control group I and group II, there is a considerable statistical significance observed (p= 0.006).This indicates that the glass ionomer restoration (GC Fuji IX) shows less degree of microleakage.

Mann Whitney U Test between group I and group III indicates that there is no significant difference observed between the groups, indicating that there is significant micro leakage observed in composite restoration.

The results of Kruskal Wallis test showed significant (P= 0.02) results in all the groups. This shows less microleakage in Fuji IX group than Tetric N ceram group. This might be attributed to the chemical bonding of glass ionomer cements to the tooth structure. More dye penetration of Tetric N ceram group might be attributed to insufficient thickness of material to withstand the shrinkage stress which might be the cause of adhesive failure and less sealing ability.

Mann Whitney U Test between group II and group III reveals that there is no significance (p=0.09) observed between the microleakage scores. Studies done by Douglas et al. [19], Puckett et al. [20], Salama et al. [21] showed Glass ionomer cements superior to composite restorations which are in accordance with present study. The results of this study are contradictory to the basic findings of Hallet et al. [22]. Erdilek et al. [23], these studies indicate that cavities filled with the composites had significantly less leakage than similar cavities filled with conventional glass ionomer cements. This variation might be because of different study designs, different dyes and thickness of the materials employed in those studies.

In the present study a two step etch and rinse technique was used which was found superior to Self etch adhesive systems due to increased water affinity of self etch adhesive systems according to a study done by Karaman et al. [10] In our study nanohybrid composites showed less degree of sealing compared to high strength glass ionomers which might be due to difficult bonding of composites to dentin, as dentin is less favourable substrate for bonding.

Rodrigues in his study showed lowest microleakage for Resin modified glass ionomer cements compared to Composite restoration. The less microleakage of glass ionomer cements is attributed to chemical bonding to the tooth structure and its ability to withstand high tensile stresses and more microleakage of composites may be due to insufficient thickness of the material and difficulty in bonding to the dentin all of which are in agreement with our study [15].

5. CONCLUSION

In the present study, Fuji IX Glass ionomer cement showed better sealing than Tetric N ceram- bulk fill but not statistically significant. Good marginal integrity of was exhibited by both the study groups. Within the limitations of the study High strength Glass Ionomer cements are considered as good alternative for class V restorations.

6. LIMITATIONS OF THE STUDY

The limitations of the present are:

1. The study requires destruction of specimens which might remove the methylene blue dye from the restoration during grinding and cleaning process hence complex methods like bacterial penetration and with the use of fluid transport model should be considered
2. The present study was done under in-vitro conditions; hence future studies should be focused to be conducted in-vivo conditions to evaluate the clinical behaviour of the tested restorative materials.
3. This study isn't considering esthetic factor. Actually an esthetic element should also be considered clinically

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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