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Comparative Evaluation of Microleakage In Class-V Cavities Restored With Amalgam And Nanofilled Composite - An Invivo/Ex vivo Study.

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Abstract

Most desirable property of a restorative material is to achieve adequate and long lasting seal between the restoration and the tooth structure, if not leads to microleakage and eventually failure of restoration. This study aimed to compare microleakage of class V cavities restored with amalgam and Nanofilled composite. Class V cavities were prepared in 30 posterior teeth planned for extraction. The sample was divided into two study groups, each containing 15 teeth. In group 1 cavity varnish was applied followed by amalgam restoration. In group 2 Tetric N bond universal and Nanofilled composite Filtek Z350 material was placed and cured for 20 seconds. Following one month of restoration, teeth were extracted and stored in distilled water until further use. For Invitro evaluation the root apices of all the test teeth were sealed, and entire tooth surfaces were covered with nail varnish except for 1mm around the restoration. Then the specimens were immersed in 0.5% basic fuchsin for 24 hours and sectioned longitudinally. The degree of dye penetration was evaluated for each section under a stereomicroscope. The extent of microleakage was ranked using a 0-4 scale. Intergroup comparison revealed no significant difference, with a P value of

0.129. However, the microleakage score was highest in group I than in group II. Microleakage was observed in both the groups, but comparatively microleakage was higher in amalgam restoration than in Nanofilled composite restoration, which can be attributed to less flexibility of amalgam.

Keywords: Microleakage, Amalgam, 8th Generation bonding agent, Nanofilled composite, Basic Fuchsin.

Introduction

The marginal seal plays a key role in the success of a restoration. Bonding to enamel is a relatively simple process, due to its structural integrity and absence of fluids in comparison to dentin, which contains low inorganic and high-water content, and the presence of collagen fibrils makes it challenging to bond.[1] Furthermore, the permeability of dentin increases significantly due to variations in the size and quantity of tubules in the superficial and deeper dentin regions closer to the pulp.[2]

Dentistry has always thrived to achieve biocompatible restorations that do not jeopardize the pulp while also preserving the cavity marginal seal. Despite the fact that resin-based composite technology development has made a substantial contribution,[3] the major disadvantage, however, is polymerization shrinkage which creates stress on the network and its bonding system, leading to poor marginal seal, marginal staining, and secondary caries which affects the longevity of the restoration.[4]

Efficient bonding of restorative materials to cavity walls will produce well-sealed and long-lasting restorations. The 8th generation adhesives along with nanocomposites are used to overcome the shortcomings of conventional resin composite and previous-generation adhesives.[5]

Dental amalgam remains the strongest and most demanded direct restorative material for load-bearing areas in posterior teeth. It has many advantages as a restorative material like strength, durability, and convenience to use. However, its main disadvantages are a metallic grey color and lack of adhesive properties. Microleakage has been identified as a significant problem with amalgam due to interfacial gap formation. Although corrosion products from amalgam alloy eventually seal the interfacial gap between the tooth surface and the amalgam restoration, the microleakage of amalgam restorations can be reduced through adequate cavity preparation, conventional varnish application, or use of dentin adhesives followed by proper amalgam condensation and burnishing.[6]

The objective of the present invivo-invitro study is to do a comparative evaluation of microleakage of class V cavities restored using varnish with amalgam and 8th generation bonding agent with Nanofilled composite restorative material.

Materials and Method

This clinical trial was conducted in the Department of Operative Dentistry and Endodontics, AME's Dental College and Hospital, Raichur. Ethical clearance was obtained from the ethical committee of AME's Dental College and Hospital, Raichur. All the patients were explained about the study and written informed consent was obtained from the patients before the procedure.

In this study, 30 human posterior teeth planned for extraction due to periodontal, orthodontic, or prosthetic reasons fulfilling inclusion criteria were selected.

Inclusion Criteria

1) Periodontally weakened teeth
2) Orthodontic extraction cases
3) Teeth extracted due to Prosthetic reasons

Exclusion Criteria

1) Teeth with caries
2) Teeth with restoration
3) Teeth with cracks

4) Teeth with hypoplastic enamel

The samples were randomly divided into two main groups.

Group A – 15 subjects with the application of varnish and amalgam.

Group B – 15 subjects with the application of 8th generation bonding agent and nanofilled composite.

The restorative procedures were carried out under rubber dam isolation. Class V cavity was prepared on the buccal surface of sample teeth, with occlusal margins in enamel and gingival margins in the cementum (Figure-1) with 2mm axial depth, 3mm occluso-gingival height, and 4 mm mesiodistal width using a diamond tapered fissure bur (Mani Dia-Burs, Japan), inverted cone bur (Mani Dia-Burs) and high-speed turbine under copious air-water coolant. The cavity preparation was done by a single operator to ensure consistent dimensions of cavity preparation.

The cavities were restored with either amalgam or composite material according to the manufacturer's instructions:

Group I: Amalgam Restoration with Cavity Varnish.

The cavity varnish (Namuvar) was applied over the prepared area in two separate coats.

The first layer of cavity varnish was applied and dried with an air syringe and the second layer was applied and again air dried. The amalgam restorative material (DPI alloy fine grain) was mixed using an amalgamator and then placed into the prepared cavity (Figure-1). Polishing was done after 24 hours.

Group II: Nanofilled Composite Restoration With 8th Generation Bonding Agent.

One coat of Tetric N Bond universal was applied onto the prepared tooth surface for 20 seconds and then the adhesive was dispersed with compressed air until a glossy film layer resulted and light-cured for 10 seconds with blue phase N polymerization light.

The Nanofilled composite (3M Espe Filtek Z350xt) material was placed in two increments. Each increment was light cured for 20 seconds. The restoration was finished using Diamond finishing burs (Shofu Inc) and final polishing was performed with Enhance finishing system discs and cups immediately after light curing the restorations.

The teeth were extracted after one month following the restorations. Extracted teeth were stored in distilled water until use.

In Vitro Evaluation

The root apices of all the test teeth were sealed with a bonding agent (IVOCLAR TETRIC N BOND UNIVERSAL 3GM) and Nanofilled composite (3M ESPE FILTEK Z350 XT). The entire tooth surface was covered with two layers of nail varnish, except for 1mm around the restoration. The specimens were then immersed in 0.5% basic fuchsin for 24 hours and sectioned longitudinally with a water-cooled low-speed diamond saw. The same examiner examined each section under a stereomicroscope at 20x magnification.

The most severe degree of dye penetration was recorded for each section. The extent of microleakage was evaluated at the tooth restoration interface based on the following criteria. (Figure – 2).

Scoring criteria[7]

Score 0 - No dye penetration.

Score 1 - Dye penetration along the occlusal wall but less than halfway to the axial wall.

Score 2 - Dye penetration along the occlusal wall but more than halfway to the axial wall.

Score 3 - Dye penetration along the occlusal wall up to and along the axial wall.

Fig.1: A. Class V Cavity preparation for Group I, B. Class V Cavity preparation for Group II, C. Group I (Amalgam restoration), D. Group II (Nanofilled composite)

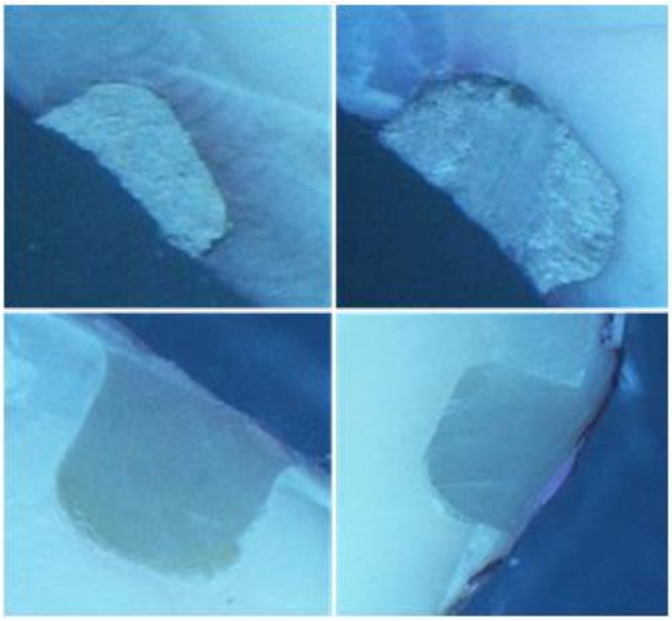

Fig.2: A. Group I – Score 1, B. Group I- Score 3, C. Group II – Score 1, D. Group II- Score 0.

Statistical Analysis

The data was compiled systematically in Microsoft Excel Sheet and subjected to statistical analyses. Descriptive statistics like mean, standard deviation, and percentages were calculated. Inferential statistics like the Mann-Whitney test is used to assess microleakage between the two groups using SPSS (Statistical Package for Social Sciences) version 20. (IBM SPASS statistics [IBM Corp. released 2011].

Results

Table 1: Descriptive Statistics

Microleakage	Minimum (mm)	Maximum (mm)	Mean	Std. Deviation
Group I	0.00	3.00	1.33	1.32
Group II	0.00	3.00	0.80	1.06

Table 2: Comparison of Microleakage Among Two Experimental Groups

Groups	Frequency (n)	Mean ± SD	Median	Mean Ranks	Mann Whitney and P value
Group I	15	1.33 ± 1.32	1.00	33.70	Mann Whitney value = 354.00 P value = 0.129**
Group II	15	0.80 ± 1.06	0.00	27.30	

Mann Whitney U Test: *P < 0.05 (significant), **p > 0.05 (Not significant)

Table 3: Distribution of Amalgam and Composite restorations for different microleakage scores

Groups	n	Score 0 N (%)	Score 1 N (%)	Score 2 N (%)	Score 3 N (%)	Score 4 N (%)
Amalgam	15	6 (40)	3 (20)	1 (7)	5 (33)	0 (0)
Composite	15	8 (53)	4 (27)	1 (7)	2 (13)	0 (0)

Discussion

Microleakage is the clinically undetectable passage for bacteria, fluids, molecules, and ions between the cavity wall and the restorative materials. Limiting microleakage has always been an important goal of operative dentistry.[8,9] In Class V cavities, restoration is more challenging when the gingival margins are placed more cervically, as isolation in the cervical areas is difficult

due to the exudation of gingival crevicular fluid which impairs the bonding of restoration.[10, 11]

The present study used the 8th generation bonding agent Tetric N-Bond Universal. It is a combination of monomers of hydrophobic (decandioldimethacrylate /D3MA), hydrophilic (hydroxyethyl methacrylate/HEMA), and intermediate (bis-GMA) nature. This combination of properties allows Tetric N-Bond Universal to reliably bridge the gap between the hydrophilic tooth substrate and the hydrophobic resin restorative, under a variety of surface conditions.[12]

Somani et al, reported that 8th generation dentin bonding agent presents better marginal integrity in comparison to the 6th and 7th generation dentin bonding agents.[13]

Ankur Mishra et al, found that the Shear bond strength of the 8th generation dentin bonding agent (FuturaBond DC), was better than the 7th generation dentin bonding agent (Adper Single Bond Universal).[14] Suresh S Kamble et al, stated that 8th generation dentine adhesive (Futura DC, Voco, Germany) resulted in the highest tensile bond strength compared to 6th (Adper SE plus, 3M ESPE) and 7th generation (G-Bond) dentin bonding agents.[15]

The results of this study showed that intergroup comparison of microleakage between traditional direct restorative material i.e., dental amalgam, and advanced nanofilled composite restorative material revealed no statistically significant difference with a P value of 0.129. However, the microleakage value was highest in the amalgam group followed by nanofilled composite group.

This can be attributed to the composition of the 8th generation bonding agent Tetric n bond universal which contains a major component of methacrylate, forms a thicker adhesive layer and a more flexible interface, which may help to counteract stress resulting from polymerization shrinkage of the resin composite.

Filtek Z350 XT, a nanofilled composite was used in this study as it has better compressive strength, less polymerization shrinkage, and higher elastic modulus when compared to conventional and microfilled composites.[16] It consists of nanomers and nanocluster agglomerated fillers.

Kanika Verma Gupta et al, stated that Filtek Z350 the nanocomposite displayed minimum microleakage while the microleakage of Self-cured glass ionomer - Ketac Molar Easy Mix was found to be maximum.[17] Itanto et al concluded that the surface roughness of a nanofilled composite resin after polishing with a multi-step technique is better than that of a nanohybrid composite resin.[18.]

Amalgam has been tested for over 165 years and has fulfilled almost all desired qualities of a restorative material except esthetics. It demonstrates favorable long-term clinical results as it has high tensile strength, excellent wear resistance, and a unique marginal sealing effect by corrosion products.[19]

T Alptekin et al, stated that the lining of amalgam restorations showed no significant effect on microleakage around restoration margins. In vivo and in vitro evaluations confirmed that microleakage was higher in resin composite restorations than in amalgam.[20] However, amalgam restoration has shown the better sealing ability of restorative margins by corrosion products and organic aggregates over time, which leads to reduced microleakage.[21] The main drawback of amalgam restoration is that it develops new marginal gaps due to thermal and mechanical stress, especially flexural stress which could lead to increased microleakage over a period of time.[22] The results of this

study are in accordance with the above-mentioned studies.

The most popular method used for measuring sealing ability is dye penetration.

Studies suggest the tracer dye can be used as its particle size is equal to or smaller than bacteria (about 2 microns), thus basic fuchsin 2% with particle size smaller than the bacteria is used. The fuchsin used in this study can be attached to carious dentin. Hence the samples were selected without carious, restoration, or crack.[23]

The success of any material is assessed by its longevity and effectiveness in an oral environment. This clinical trial was conducted to determine the effectiveness of a newer 8th generation bonding agent with nanofilled composite in reducing polymerization shrinkage, which in turn leads to reduced micro gap formation compared to long-lasting silver amalgam restoration.

Conclusion

Within the limitations of this in vivo/invitro study, it can be concluded that:

- Class – V cavities restored in both groups using nanofilled composite & amalgam showed microleakage.
- Comparatively, group II (Tetric N Bond UNIVERSAL + Filtek Z 350) showed less microleakage than group I (Varnish + Amalgam).

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