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Original Article

Dentistry Section

An in vitro Evaluation of Microleakage of Posterior Teeth Restored with Amalgam, Composite and Zirconomer – A Stereomicroscopic Study

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ABSTRACT

Background: Numerous restorative materials are being used in dentistry to achieve adequate strength and restore aesthetics. However, a perfect ideal restorative material has still eluded dentist. Dental amalgam is versatile material with self-sealing property, but is unaesthetic. Other restorative materials like, composites require conservative preparation, but exhibits polymerisation shrinkage resulting in microleakage. To overcome these drawbacks a high strength restorative material reinforced with ceramic and zirconia fillers known as zirconomer has been introduced. The aim of this study was to evaluate the micro-leakage of these three different restorative materials.

Materials and Methods: Thirty non-carious human permanent first and second molars were utilized in this study. Class I cavities were prepared on the occlusal surface; cavities were then restored with amalgam, composite and zirconomer as per manufacture's instruction. All samples were stored for 24 hours in distilled water followed by thermocycling. The entire tooth surface was painted with two coats of varnish to within 1mm of the restoration margins. The teeth were immersed in dye. Teeth were sectioned and observed under stereomicroscope.

Result: In this study the zirconomer exhibited the highest micro leakage as compared to composite and amalgam but composite having higher micro leakage as compared to amalgam and lower micro leakage as compared to zirconomer.

Conclusion: Even though composite and amalgam are being marketed aggressively and new material like zirconomer are on origin, amalgam still proves to be one of the best materials.

Keywords: Aesthetics, Dye penetration, Thermocycling, White amalgam

INTRODUCTION

Marginal microleakage is commonly observed with various restorative materials which can lead to marginal staining and secondary caries and if not treated in time, it can cause pulpal pathology. These factors have been cited as the main reasons for restoration replacement. Controlling microleakage has always been an important goal of operative dentistry [1].

Dental amalgam has been used by dentists for more than a century. It has many advantages as a restorative material, because it has high strength, durable and easy to use. However, amalgam fillings have a number of drawbacks, such as, corrosion; they do not fulfill aesthetic demand; making undercuts for mechanical retention necessary, mercury toxicity and lack of adhesion to tooth structures [2].

Recently popularity of resin-based composite restoration has increased than amalgam restoration because of its excellent aesthetic and other favourable characteristics. However, failure is also seen in composite restoration in posterior dentition as excessive wear, polymerization shrinkage, open inter proximal contacts, tooth sensitivity, secondary caries, irreversible pulpitis and restoration fracture [2].

To overcome drawbacks of above materials a high strength restorative material which has been reinforced with ceramic and zirconia fillers known as zirconomer (white amalgam) has been recently introduced in dentistry [3].

The success of any material is assessed by its longevity and biocompatibility in oral environment. Thus clinical testing of new material is more in determining the effectivity and biocompatibility of newer material than invitro screening [4].

The objective of the present invitro study is to compare the sealing ability of the amalgam, composite and most innovative restorative materials being introduced in clinical practice, zirconomer (white amalgam).

MATERIALS AND METHODS

Sample selection criteria

Thirty non-carious human periodontally compromised permanent first and second molars were utilized in this study because these teeth have a wide occlusal surface which is most suitable for class I cavity preparation. The teeth were cleaned by scraping to remove debris and stored in saline before use [5]. The present study was designed and executed in the Department of Conservative Dentistry and Endodontics at Darshan Dental College and Hospital, Udaipur in 2013.

Sample preparation

Class I cavities were prepared on the occlusal surface of the extracted teeth to be 4mm wide, 2mm deep and 4mm long using a high speed hand piece with air-water coolant, ISO size (No.010) straight fissured and (No.014) inverted cone diamond burs. After every five cavity preparation, bur was replaced. Dimension 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 [5].

Restorative procedure

The teeth were randomly divided into three experimental groups of 10 teeth in each. Group-I amalgam (Dispers alloy, DENTSPLY India Pvt. Ltd., Gurgaon), Group-II composite (Ceram-x-duo, DENTSPLY, Germany) and Group-III zirconomer (SHOFU INC. Kyoto, Japan). All the prepared cavities were then restored with amalgam, composite and zirconomer as per manufacture's instruction. Amalgam was hand condensed into the preparation to cover all walls and cavosurface margins and then carved to the tooth contour with a sharp carver. After 72 hours, the restorations were polished (SHOFU INC.

Kyoto, Japan). Composite samples prepared by incremental layer technique and polished (SHOFU INC. Kyoto, Japan). Zirconomer samples restored by bulk placement and polished (SHOFU INC. Kyoto, Japan). All three group sample stored for 24 hours in distilled water.

Thermal cycling and microleakage testing

The samples were then thermo cycled for 500 cycles between 5°C ± 2°C and 55°C ± 2°C with dwell time of 30 seconds. Then the entire tooth surface was painted with two coats of air resistant varnish to within 1mm of the restoration margins [5]. The teeth were immersed in 0.5% methylene blue dye for 24 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 (10X) magnification [5], and dye penetration was evaluated at the tooth–restoration interface based on the criteria given in [Table/Fig 1].

Score	Tooth–restoration interface	Score criteria (in proportions)
0	No dye infiltration.	0.00
1	Dye penetration up to the first third of the prepared cavity wall	0.25
2	Dye penetration up to the second third of the prepared cavity wall	0.50
3	Dye penetration onto the entire prepared cavity wall	0.75
4	Dye penetration onto the entire prepared cavity wall and the pulpal wall	1.0

[Table/Fig-1]: Dye penetration was evaluated at tooth–restoration interface based on the following criteria: (in proportions)

STATISTICAL ANALYSIS

A one-way ANOVA test was used to determine whether there were significant differences between groups. The level of significance was established as p<0.05 for the test. SPSS 19 was used to analyse the data.

RESULTS

The mean and standard deviation of micro leakage scores for all groups are presented in [Table/Fig 2,3]. The ANOVA test revealed significant differences (p<0.05) in mean microleakage scores among the groups (p= 0.000). Group- I Amalgam had lower micro leakage score (0.200) than the Group- II Composite score (0.475), this different was significant (p= 0.005). Significant difference (p= 0.010) was also found in between Group- II Composite score (0.475) and group- III Zirconomer score (0.725). Group- III Zirconomer had higher microleakage than group- I Amalgam. This difference showed statistically highly significant (p= 0.001).

Group	Mean (m)	S.D	Percentage of microleakage
Group-1 (Amalgam)	0.2000	0.15811	20 %
Group-2 (Composite)	0.4750	0.18447	47.5 %
Group-3 (Zirconomer)	0.7250	0.18447	72.50 %

[Table/Fig-2]: Mean value and standardized deviation of microleakage score in proportion

Group Comparison	Mean Difference	p-value
Amalgam & Composite	0.275	0.005
Amalgam & Zirconomer	0.525	0.001
Composite & Zirconomer	0.250	0.010

[Table/Fig-3]: Mean difference and P-value of microleakage score in proportion

DISCUSSION

There is a constant search for the material and technique that ensures adhesion to the tooth structure in order to minimize the leakage potential. Microleakage is used as a measure by which clinicians and researchers can predict the performance of a restorative material. The present study was designed to evaluate the sealing properties of amalgam, composite and white amalgam (zirconomer).

Alptekin T et al., conducted in vivo and in vitro studies and concluded that coating the cavity walls with cavity varnish could have no effect on decreasing marginal leakage in amalgam restorations and they also concluded resin composite restorations revealed higher microleakage scores than amalgam restorations [2]. Class-I amalgam restoration had lower microleakage than bonded composite concluded by Baghdadi et al., [6]. Similar results were found in the present study.

Hersek et al., used extracted human teeth and compared microleakage of the different filling materials with the auto radiographic method. These authors stated that amalgam restorations exhibited greater leakage than posterior resin composites [7]. Contradictory results were found in the present study showing greater leakage of other materials than amalgam.

Many studies were done on microleakage of amalgam and composite but this is the pioneer study showing the microleakage of the new innovative dental restorative material that is zirconomer (white amalgam). Microleakage is defined as the passage of bacterial fluids, molecules and ions between the cavity walls and the restorative materials, which is not clinically detectable and is one of the most important reasons for recurrent caries and pulpitis [8]. Marginal micro leakage should be considered in the evaluation of a restorative material, because it has been directly related to the success or failure of the restorations [1]. Highest marginal quality should be pursued in order to increase success rates and to decrease postoperative sensitivity, marginal discoloration, and potential secondary caries [9].

When an Amalgam is initially placed, a micro space exists between the amalgam restoration and tooth structure. The mechanism for the resolution of this problem is considered to be the sealing of the margins by corrosion products and possibly organic aggregates [10].

Now-a-days patients are more concerned regarding the aesthetic hence, composite is commonly used as a restorative material in dentistry. One of the main drawbacks associated with composite restoration or the posterior restorative material is its shrinkage during polymerization which creates stress on the network and its bonding system. This leads to marginal staining, poor marginal seal and recurrent caries, which affects the longevity of the restoration [2].

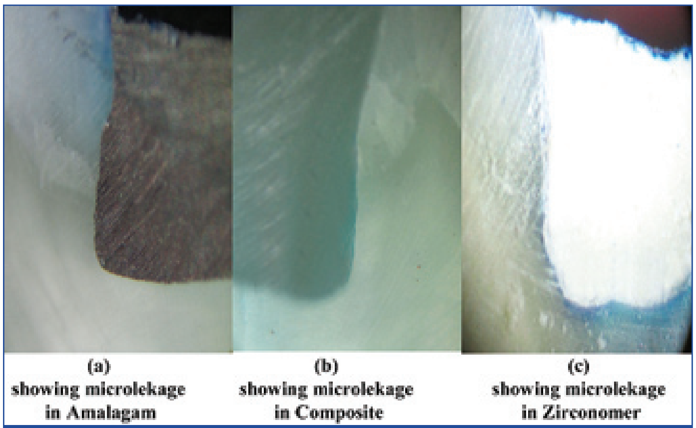
With the decline in popularity of amalgam in recent years and drawback of composite there is a need for an equally strong & bondable material ease of replacement. Zirconomer, a new class of glass ionomer restorative material, exhibiting strength and durability of amalgam, along with bondable and fluoride releasing property of glass ionomer cement at the same time it eliminates the hazardous property of amalgam because of mercury [3].

Addition of zirconia as filler particle in the glass component of Zirconomer improves mechanical properties of the restoration by reinforcing structural integrity of the restoration in load bearing areas where amalgam is material of choice. Combination of outstanding strength, durability and sustained fluoride protection deems with chemical bonding, it is ideal for permanent posterior restorations in patients with high caries incidence as well as cases where strong structural cores and bases are required [3].

Class I cavities were prepared because of its 'c' factor, i.e. ratio between number of bonded and unbonded surface by Roberson et al., and Santini et al., [11,12]. In this study, thermo-cycling was done to mimic intra-oral temperature variations compatible with oral cavity [13].

The dye penetration method used for measuring sealing ability is the most popular. Various dyes can be used such as methylene blue, India ink, basic fuchsin and silver nitrate with developer. Out of the various studies methylene blue has been proved to be useful aid in endodontics [14]. Methylene blue (0.5%) was used in this study because of its low cost, ease of application and low molecular weight of the dye, which is smaller than bacteria. Tests using dyes, could detect leakage where bacteria could not penetrate. Methylene blue was employed as a tracer to evaluate the degree of infiltration. Dentinal tubules permeability and smaller particle size could cause an over estimation of the relevance of this infiltration. Average size of bacterial cell is larger than the calculated area of Methylene blue which is approximate 0.52nm^2. In general, diameter of bacterial cell is 0.3-1.5 microns therefore this technique can not differentiate between too wide and too narrow gap to allow for bacterial leakage [15].

According to the results, in this study zirconomer exhibited the highest micro leakage as compared to composite and amalgam but composite having higher micro leakage as compared to amalgam and lower micro leakage compared to zirconomer [Table/Fig 4].



[Table/Fig-4]: Microleakage in different materials

CONCLUSION

Even though composite and amalgam are being marketed aggressively and new material like zirconomer are on origin, amalgam still proves to be one of the best materials when you consider micro leakage as a factor. Despite of the newer material, zirconomer had highest microleakage as compared to composite and amalgam.

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