Research Article

Comparison of Microleakage in Chemically Bonded and Mechanically Bonded Restorations After Using Chemomechanical Caries Removal Technique in Primary Teeth

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Abstract

Background: The success of restoration depends upon the marginal seal of restorative material with tooth structure. Marginal gaps result in microleakage and development of secondary caries.
Objective: To evaluate microleakage in chemically bonded and mechanically bonded restorative materials after using chemomechanical caries removal technique in primary teeth.
Methods: This in vitro experimental study assessed the microleakage associated with high viscosity glass ionomer and amalgam after using chemomechanical caries removal technique in primary teeth. Forty specimens were divided into four groups of ten. Group A1and BI (restored with Ketac Molar and Aristaloy 21 respectively) thermocycled at 1000 while group A2 and B2 (restored with Ketac Molar and Aristaloy 21 respectively) thermocycled at 5000 cycles. Dye penetration test was performed to check the microleakage. Fisher's exact test was used to contrast the microleakage between groups at thermocycling levels.
Results: Chemically bonded and mechanically bonded restorative materials (Ketac Molar and Aristoly 21 respectively) showed varying degree of dye penetration. In group A1, 70.0% teeth showed microleakage score 0 whereas in group B1, 20.0% teeth showed microleakage score 0. In group A2, 70.0% teeth showed microleakage score 0 whereas in group B2, only10.0% teeth showed microleakage score 0. Data was analyzed using SPSS 20.0. Fisher's exact test showed significant results after 1000 and 5000 cycles of thermocycling (with p-value 0.044 and 0.039 respectively).
Conclusion: High-viscosity glass ionomer restorations showed significantly less microleakage as compared to the amalgam restorations.

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Key Words: Microleakage, Primary teeth, Chemically bonded restorations, Mechanically bonded restorations, Chemomechanical caries removal technique

Introduction

For the success of a permanent dental restoration, microleakage is one of the major factors.[1] Microleaage is seepage of debris and fluids between the restorative material and tooth structure.[2] So microleakage results in failure of the filling materials to attain well sealed margins and development of secondary caries.[3] it results in about 50% of replacement procedures.[4] If deep carious lesions left untreated, these may cause pulp inflammation, leading to necrosis, abscess formation and at last loss of tooth.[5] Decayed teeth are responsible for about 51.14% of tooth loss between 20-30 years of age while 29.11% of tooth loss due to decayed teeth is seen in people above 40 years.[6]

Different types of restorative materials are available.[7] Mostly used restorative materials are amalgam, glass ionomer, compomer and composite resin.

Although amalgam is considered a gold standard material in dentistry but has adverse effects too, for example healthy tooth structure cutting to prepare a cavity and mercury toxicity. To overcome such problems, filling materials having bonding properties are widely used because they are easy to use, aesthetic and functionally acceptable. However, there is still a conflict about the choice of best filling material.[8]

Dental caries is recognized as two successive layers. The surface layer called infected dentin is soft necrotic zone incapable of remineralization due to presence of bacteria. Second layer called affected dentin, can be remineralized.[9] Caries removal using bur drilling is quick but may cause thermal damage to pulp and unnecessary cutting of tooth structure.[10]

To overcome such problems, several minimal invasive procedures are introduced like air abrasion, laser preparation and chemomechanical caries removal technique.[11] Chemomechanical caries removal technique is used in the current study. Chemomechanical caries removal agent like papacarie removes only infected dentin, preserving the affected dentinal layer that can be remineralized. In addition, chemomechanical caries removal technique produces irregular and rough dentinal surface without smear layer which is well suited to modern adhesive restorative materials.[12] Papacarie based carious tissue removal is efficacious for bacterial removal.[13] But limited literature is available regarding the outcome of papacarie on microleakage of restorative materials.[14] Supplementary studies are still needed to authenticate if this technique would offer a tooth surface appropriate for marginal seal of restoration.

The rationale of this study is to check the microleakage of chemically bonded and mechanically bonded restorative materials after using chemomechanical caries removal agent. So that the best restorative material can be selected after using chemomechanical caries removal technique in primary teeth.

Methods

After taking ethical permission, forty extracted primary molars with occlusal caries were selected from Paediatric Dentistry Department, de'Montmorency College of Dentistry, Lahore during May 2018 to August 2018. Molars having occlusal caries with depth > 2mm, having no fractures or cracks and extracted for orthodontic intervention or exfoliative mobility. While molars having proximal caries, fractures or cracks, intrinsic discoloration and cervical abrasion or erosion were excluded. As patients were minor so consent was achieved from their parents after clarifying them about the research in detail. All tooth surfaces of primary molars were scaled manually to remove remnants of periodontal ligaments or any calculus present. These primary molars were preserved in formalin 2% (having pH=7) for 14 days and subsequently in saline solution. Papacarie (containing 10% papain)[15] gel was applied on the carious lesion for 30 seconds using a plastic filling instrument (Fig.1). When applied papacarie became cloudy, it was scrapped gently and was removed by using spoon shaped excavator. Papacarie gel was applied again on excavation site for half a minute. This process was repeated until carious cavity became glassy which showed that the cavity was now caries free.

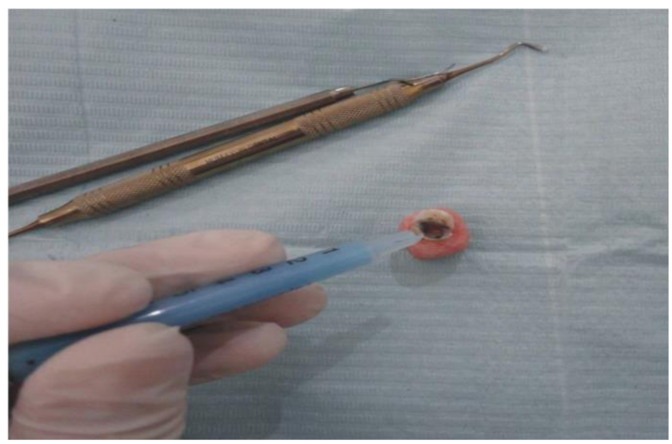


Figure 1: *Papacarie application in carious cavity*

This cavity was cleaned by using sterile and moistened pellet of cotton. The complete caries removal was confirmed by using tactile (smooth move of explorer) and visual (no discoloration) methods. The prepared occlusal cavities were thoroughly cleaned with water and gently air dried. To compare the microleakage of two restorative materials, prepared cavities were divided into four experimental groups on the basis of filling material and number of cycles of restored tooth (thermocycling viz. 1000 cycles and 5000 cycles) (Table 1).

Table 1: *Experimental Groups*

Groups	***Restorative material used***	***Subjected to thermocycling between 5ºC-55ºC for***
Group A1 (n = 10)	High viscosity glass ionomer (Ketac Molar, 3M ESPE, Germany)	1000 cycles
Group B1 (n = 10)	Amalgam (Aristaloy 21, Cookson, United Kingdom)	1000 cycles
Group A2 (n = 10)	High viscosity glass ionomer (Ketac Molar, 3M ESPE, Germany)	5000 cycles
Group B2 (n = 10)	Amalgam (Aristaloy 21, Cookson, United Kingdom)	5000 cycles

In group A1 and A2, cavities were restored with high viscosity glass ionomer (Ketac Molar), while in group B1 and B2, cavities were restored with amalgam (Aristaloy 21). After restorations, teeth in both groups were stored in saline at 37ºC for 72 hours separately. Later they were polished. All the cavity preparations, restorations, finishing and polishing procedures were performed by the same individual.

For the restoration with high viscosity glass ionomer, Ketac™ Conditioner was applied to the prepared cavity surfaces for 10 seconds to remove the smear layer. Cavity was rinsed with water, then dabbed dry with cotton pellets. Ketac Molar cement was mixed in the ratio of 3:1 (mg/mL) using plastic spatula on a mixing paper and then applied into the cavity and shaped. The restoration was protected with Ketac Glaze. After the setting, restoration was finished with finishing and polishing burs (Shofu Inc., Kyoto, Japan). Finally, Ketac Glaze was applied again.

For amalgam restoration, two coats of cavity varnish (Copalite, Cooley & Cooley Ltd., Houston, TX, USA) were applied over prepared area with a cotton pellet. After first and second applications, cavity was gently air dried. Amalgam was triturated in an amalgamator at speed of 3000 rpm for 10 seconds and was condensed in small increments using amalgam condenser until the cavity was slightly overfilled. The restorations were surfaced with a ball ended burnisher prior to and after carving. After 24 hours, amalgam restorations were finished using Dura-Green finishing stones (Shofu Inc., Kyoto, Japan) and polished using amalgam polishing kits (Shofu Inc., Kyoto, Japan).

Teeth were subjected to thermocycling in saline between 5ºC (±2) - 55ºC (±2). Subgroup A1 and B1 were subjected to thermocycling for 1000 cycles while subgroup A2 and B2 were subjected to thermocycling for 5000 cycling for 30 seconds each.

Microleakage Test

After thermocycling, all tooth surfaces except the restoration and 1 mm zone adjacent to its margins were immediately covered with two coats of nail polish. The root apices of the teeth, if any, were sealed with sticky wax. The nail polish was left to dry for one hour. Each coated sample was placed separately in basic fuchsine dye (2%) for eight hours at 37ºC.[16] Then specimens were removed from the dye and were thoroughly washed below tap water. Nail varnish coating was stripped by peeling and scraping and wax removed. The specimens were washed again in tap water until the dye was removed. The specimens were then dried, embedded in acrylic resin blocks and allowed to set.

Teeth were then sectioned through the middle of cavity restoration buccolingually in occlusoapical direction. Diamond saw of 0.3 mm (Ham Co. Machines, Inc., Rochester/USA) in a slow speed hand piece with water coolant was used to section specimens. Each section was then examined under stereomicroscope (Olympus Corporation, Tokyo, Japan) having camera for image collection at 40X magnification by a single examiner to measure the depth of dye penetration at the two surfaces of the cavity. The depth of dye penetration was measured and scored based on the following scale of dye penetration. Both sections of a specimen were scored according to dye penetration scoring system (table 2) and highest score was recorded according to ISO/TR 11405:2002 standard.[16]

Table 2: *Scoring System to Evaluate Dye Penetration*

Score 0	No dye penetration
Score 1	Dye penetration limited to the enamel of axial wall
Score 2	Dye penetration past the enamel up to the dentin of the axial wall
Score 3	Dye penetration past the axial wall involving the floor of the cavity

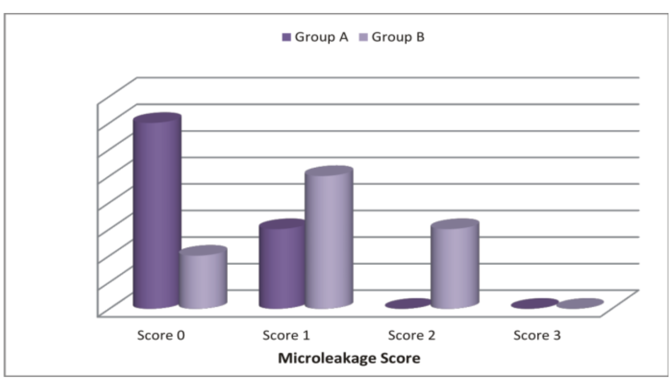
Statistical Analysis

Data (microleakage scores) was analyzed using Statistical Package for Social Sciences (SPSS 20.0). Frequency with percentage was calculated for descriptive statistics. Fisher's exact test was used to contrast the microleakage between groups at thermocycling levels. P-value ≤ 0.05 was taken as significant statistically

Results:

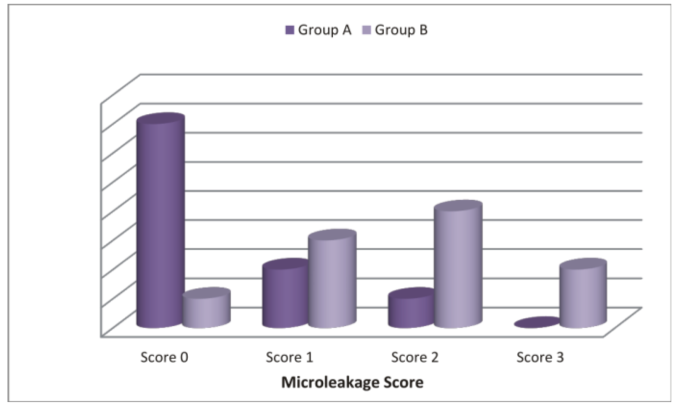
The two restorative materials used showed varying degree of dye penetration. In group A1, microleakage score 0 was observed in 70.0% teeth whereas in group B1, microleakage score 0 was observed only in 20.0% teeth (Graph 1). In group A2, microleakage score 0 was observed in 70.0% teeth whereas in group B2, microleakage score 0 was observed only in 10.0% teeth (Graph 2). Fisher's exact test showed significant results after 1000 and 5000 cycles of thermocycling.

Fisher's exact test



Graph 1: *Microleakage Scores of Restorative Materials after 1000 Cycles*

Fisher's exact test



Graph 2: *Microleakage Scores of Restorative Materials after 5000 Cycles*

Discussion:

Microleakage is used as a measure to assess the performance of filling materials. Therefore, there is regular research for dental materials and techniques to improve the bonding of the restorative material to the tooth structure so that microleakage can be controlled.[17]

This study was designed to evaluate the sealing ability of chemically bonded and mechanically bonded restorative materials after using chemomechanical caries removal technique

There are many methods of assessing microleakage. These include radioactive isotopes, dyes, air pressure, bacterial activity, scanning electron microscope, neutron activation analysis, dye penetration and microcomputed tomography.[18] But in this study, dye penetration method of assessing microleakage is used because it is simple and cost effective. In addition, following thermocycling, it produces similar condition that restorative materials face in oral cavity. Penetration of leakage is converted into 0-3 score to calculate the severity of microleakage.[1]

Thermocycling is a standard protocol to mimic the aging of restorative materials and interlinked in the literature when bonded materials are evaluated.[18]

As restorative materials face occlusal forces as well as temperature variations intraorally, thermocycling is used to create artificial oral environment.[1]

In this study, amalgam is used as mechanically bonded restorative material. Although there is controversy about the use of amalgam. But amalgam is still material of choice for direct restorations especially of posterior teeth because of its good mechanical properties like durability, high compressive strength, wear resistance, easy manipulation and low technique sensitivity.[19]

In most of tooth-colored restorations, polymerization contraction is known to be accountable for many clinical problems. Therefore, in this study high viscosity glass ionomer is selected as chemically bonded restorative material because of significantly low contraction value than that of other types of glass ionomer. This possibly is related to the fact that high-viscosity glass ionomers have comparable coefficient of thermal expansion to that of tooth substance. High-viscosity glass ionomer sets faster due to the fine size glass particles, high powder: liquid ratio and high molecular weight anhydrous polyacrylic acids.[20] These characteristics may be accountable for Ketac Molar showing good marginal seal.

In the current study, microleakage is seen to some extant with both chemically and mechanically bonded restorative materials. But mechanically bonded material show more microleakage as compared to chemically bonded material. This could be explained due to the fact that there is difference in co-efficient of thermal expansion between tooth structure and amalgam which result in gaps between amalgam and tooth structure after thermocycling.[21]

The occurrence of less microleakage in high viscosity glass ionomer than amalgam indicates that chemical bonding is better between tooth and restoration in papacarie treated teeth which results in less chances of microleakage. Previous studies show that chemomechanically treated dentin exhibit higher surface energy and more affinity for adhesive materials resulting in better quality bonding than the conventionally treated dentin.[22]

Papacarie also removes the smear layer. This provides a clean surface for strong bonding. The good adhesion of filling material with tooth surface results in decreased chances of microleakage.[12] This makes the glass ionomer a more suitable option for the restoration in primary teeth after using chemomechanical caries removal technique.

Ranadheer et al. evaluated the microleakage of glass ionomer and amalgam. They concluded increased microleakage in amalgam as compared to glass ionomer which is in accordance with the findings of the present study.[21] In another study, Mazumdar and colleagues evaluated the microleakage between amalgam and glass ionomer and concluded that none of the two materials was free from microleakage which is in accordance with the findings of the present study.[2]

Albeshti and shahid evaluated high microleakage in glass ionomer than amalgam in their study which is in contrary to the present study. The reason for this difference is likely to be the use of mechanical caries removal technique, while in the current study, chemomechanical caries removal technique is used which improves the chemical bonding of the restorative material.[23]

As chemomechanical caries removal technique is a painless noninvasive technique of caries removal, so there is a potential interest for use especially in children because children more commonly experience anxiety and have fear of pain. Therefore deciduous molars were selected for the study as they are most commonly affected by carious attack.[24]

Occlusal caries lesion is small externally, widens towards depth as it approaches dento-enamel junction. Once within dentin, caries spread out laterally, as well as, progress towards pulp. This unorganized pattern of caries spread and macro scratches will help in retention of restorative material.[25]

The major limitation of this research is that it was an in vitro study. However, best way to test the restorative materials would be in the oral cavity.[17]

In addition, this research was conducted in primary teeth and the results obtained cannot be applied to the permanent dentition because of the variations in composition and morphology of primary and permanent teeth. Moreover the permanent teeth restorations have to undergo higher masticatory stresses and are supposed to stay in the mouth for longer period of time.

Conclusions:

High-viscosity glass ionomer restorations showed significantly less microleakage as compared to the amalgam restoration.

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