A comparative study evaluating the microleakage of different types of restorative materials used in restoration of pulpotomized primary molars

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ABSTRACT

Background: Possibly the greatest deterrent to the development of an ideal restorative material is the leakage that occurs along the restoration, tooth interface. There is yet no truly adhesive dental material that exactly duplicates physical properties of the tooth structure. This in vitro study was carried out to compare the microleakage of two types of restorative materials used in pediatric dentistry Colored light curing compomer (Twinky star) and nano ceramic restorative material (Ceram.x) with that of amalgam by measuring their ability to prevent dye penetration.

Materials and Methods: Standardized Proximo-occlusal cavity preparations were prepared in 30 extracted sound primary first lower molars. Pulpotomy was performed, and pulpotomy paste filled the pulp chamber with hard setting cement over it all have same occlusal depth. The teeth were then randomly divided into three groups: Group A: filled with Amalgam. Group B: filled with compomer (Twinky star). Group C: filled with nano ceramic (Ceram.x). After that the teeth were stored in distilled water for 30 days at 37°C in an incubator and during the period of storage the teeth were subjected to 300 thermal cycles (10 cycles each day), then sectioned to be examined under the stereo microscope.

Results: Data was analyzed using ANOVA test with help of spss soft ware, even though nano ceramic (Ceram. X) showed higher resistance to dye penetration, when compared to compomer (Twinky star and amalgam), there were no significant differences between the three studied groups in their resistance to dye penetration.

Conclusion: Depending on the ability to prevent marginal leakage, nano ceramic (ceram.x) and compomer (Twinky star) restorative materials can be used as an alternative to amalgam in restoring pulpotomized primary teeth.

Key words: Amalgam, Colored light curing compomer, Twinky star, Nano Ceram.x restorative material, Microleakage. (J Bagh Coll Dentistry 2012;24(2):150-154).

INTRODUCTION

Adherence of the restorative material to the cavity walls is one of the most important characteristics for it to be proven as an ideal material because it prevents microleakage (1). Microleakage is defined as the chemically undetectable passage of bacteria, fluids, molecules or ions between the cavity walls and restorative materials. This seepage can cause hypersensitivity of restored tooth, tooth discoloration, recurrent caries, pulpal injury and accelerated deterioration of the restorative material (2). One of the most important problems today of the restorative dentistry is the failure of restorative material to obtain a complete bond with the enamel and dentin, the formation of microfissures, the penetration of ions, molecules, bacteria and fluids into these fissures and the occurrence of postoperative pain, discoloration at the cavity edges, secondary decays and pulpal inflammations. It has been reported that this phenomenon, referred to as the microleakage, is due to the inadequacy of marginal adaptation between the restoration material and cavity wall.

The microleakage is determined today by many in vivo and in vitro techniques such as; staining, which, is the most preferred one (3). Many changes have occurred in development and availability of restorative materials for children. The amalgam has been used for more than 150 years as a restorative material due to its satisfactory clinical characteristics: Low sensitive technique (moisture contamination), satisfactory longevity on primary teeth and diminished microleakage related to corrosive products in tooth/restoration interface. In addition, amalgam is inexpensive and easy to handle (4).

Compomers contain glass ionomer cement combined with visible light polymerized resin component. Their excellent physical properties along with fluoride releasing ability, minimal steps in placement and composite like esthetics make them the strongest and most esthetically desirable material. Most restorative materials show varying degrees of marginal leakage because of dimensional changes and lack of adaptability to cavity walls. Microleakage investigation of compomers and their comparison with other materials have compared only a limited number of products but in general have shown adequately sealed restoration margins (5).
Since nanotechnology was introduced to dentistry, nano composites with filler sizes ranging from 0.01 to 0.04 mm have been developed. Nanocomposites have many advantages, such as reduced polymerization shrinkage, increased mechanical properties, improved optical characteristics and better gloss retention. Ceram-X (Dentsply DeTrey, Konstanz, Germany), was developed after introduction of the nanotechnology in dentistry, it's a light cured, radiopaque restorative material for restoration of anterior and posterior teeth. It combines Nanotechnology, with improved organically modified Ceramic particles. Nano ceramic (Ceram-X) contains glass fillers (1.1–1.5 μm) but differs from conventional hybrid composites by two important features: methacrylate-modified silicon dioxide containing nano-filler (10 nm) substitute the microfiller that is typically used in hybrid composites (agglomerates of silicon dioxide particles). According to the manufacturer’s data, filler concentration is 76% by weight and 57% by volume.

Microleakage performance may be useful for comparative assessment of materials and selection of restorative materials with adequate marginal seal is directly related to the success and longevity of the restorations. This study designed to assess the microleakage of different restorative materials:

1. Amalgam.
2. Compomer (Twinky star).
3. Nano ceramic (Ceram-X).

Used in restoration of pulpotomized primary molars

**MATERIALS AND METHODS**

Thirty sound human primary lower first molar teeth free of dental caries extracted for orthodontic purpose (serial extraction) were collected. After extraction; the teeth were cleaned with rubber cup and pumice and scaled by ultrasonic scalar to remove any calculus on the surfaces of the teeth. The teeth stored in distilled water containing thymol crystal 1%, at room temperature. The teeth were examined for cracks by the use of magnifying eye lens. Any tooth associated with cracks was excluded and only sound teeth were used.

Standardized class-II mesio-occlusal cavity was prepared. A tungsten carbide fissure bur No.330 in a turbine hand piece was used with proper water cooling to prepare the cavities. The buccolingual width of occlusal preparation was (2.5mm) just enough to allow the entrance of no. 6 round bur while the depth of occlusal preparation was (6mm) (measured from pulpal floor to cuspal tip). The buccolingual width of proximal box was (4mm) and the gingival seat was located (2mm )coronal to CEJ . The length of proximal buccal and lingual walls was (4mm) (measured from gingival seat to cuspal tip). Pulpotomy procedure was done for all teeth and floor of pulp filled with pulpotomy paste that is a mixture of one drop of eugenol with one drop of tricresol formalin mixed with zinc oxide eugenol powder then hard setting cement base of zinc phosphate cement was applied over it, and the occlusal depth of cavity calibrated by reamer with stopper to be the same depth from cusp tips to the cement base for all the teeth about 1.5mm.

The teeth were divided into three groups of ten teeth each:

- Group A: was restored with amalgam.
- Group B: was restored with compomer (Twinky star).
- Group C: was restored with nano ceramic (Ceram-X).

The teeth were then stored in incubator for 30 days in distilled water at 37°C each day the teeth were subjected to 10 thermal cycles (300 cycles). This procedure was done to simulate temperature changes in the oral environment which might result in changes in the microspace around the restoration. Each tooth was placed in block of cold cure acrylic resin to seal the root apex and furcation area to the area 1mm below the cement enamel junction, then the crown with the block was sealed with two layers of nail varnish to within approximately 1mm of the restoration margins to prevent dye penetration in areas other than the exposed margins. All the teeth were immersed in 2% methylene blue dye solution at 37°C in an incubator for 24 hours (1, 3, 10). Then all the teeth were removed from the dye and washed under running water. Each tooth was then sectioned into two halves and two samples were prepared from each half by sectioning through the center of each restoration, this provide two occlusal and two gingival margins allowing for identification of microleakage through dye penetration. The degree of microleakage was determined by the degree of dye penetration from the margins of the restoration towards the pulp chamber by viewing under a binocular stereo microscope with 10-20 X magnification.

Under a stereomicroscope the teeth were studied to measure the depth of dye penetration at the two surfaces of the cavity and the score which was higher was given as score to the particular tooth. All the scoring was carried out by a single person.
and as seen clinically in figures (2), (3), (4), (5) and scoring criteria used for the study was as follows (9):

- 0 = No dye penetration
- 1 = Dye penetration between the restoration and the tooth into enamel only.
- 2 = Dye penetration between the restoration and the tooth in the enamel and dentin.
- 3 = Dye penetration between the restoration and the tooth into the pulp chamber.

ANOVA test was used to find any statistical significant differences among the three studied groups.

**RESULTS**

Table (1) shows the descriptive statistics for the result of methylene blue dye penetration score for the three materials used in present study, this table shows that the higher mean score of dye penetration was for compomer (Twinky star) (1.80±0.92) followed by amalgam (1.70±1.16) and the lower mean was found for nano ceramic (Ceram.x) (1.20±1.03). ANOVA test showed no significant difference among the three groups (F=0.952 P=0.398).

The percentage of each score is shown in table (2), this table shows that percentage of teeth with absence of dye penetration (score 0) was higher among nano ceramic (Ceram. x) (30%) than both amalgam (20%) and compomer (Twinky star) (10%). On the other hand, concerning maximum score of dye penetration (score 3) the higher percentage of teeth was found for amalgam (30%) followed by compomer (Twinky star) (20%) and lower percentage was found for nano ceramic (Ceram.x) (10%).

Figure (1) shows that the percentage of dye penetration score (score2) was higher for teeth filled with compomer (Twinky star) (50%) than both amalgam and nano ceramic (Ceram.x) (30%).

**DISCUSSION**

Dye penetration is used as a measure to evaluate the performance of the restorative materials. This in vitro study was carried out to evaluate and compare the micro leakage of two new materials in the market and compare them with amalgam (9). The standardized design of a class II cavity preparation and pulpotomy procedure for the sound primary molars used in this study are more commonly representing the main percentages of restorations done for children because most of patient come with severe pain because of pulpal involvement and most of them come with proximal lesions so cavity preparation in proximal boxes extended to the enamel 2mm above cementoenamel junction for standardizations for the three restoratives materials to be the same to support the validity of the study design (9,18).

Thermal cycling is commonly employed in dye penetration test of dental materials. The regimen of thermal cycling was included in this study because it was commonly used in other previous studies (1,10,19). The upper temperature (55°C) may be encountered in vivo, but it was perceived that higher temperature is relatively hot and may cause discomfort and this two border of temperature (4°C and 55°C) simulating changes in temperature in oral cavity (in vivo) and also samples are thermocycled through 30 days as aging process to see effect of time on the restoration (5,20).

Many studies had been done on microleakage of class II of posterior permanent teeth restorations and the findings obtained had been assumed to apply to primary teeth, but some evidences suggest significant chemical and morphological differences between primary and permenant dentition This may be of fundamental importance because of morphological differences such as a larger tubular diameter and less mineralization of intertubular dentin areas (21,22). Furthermore, information regarding microleakage in restorations of pulpotomised primary human molars are limited, for these reasons this study was done to estimate microleakage of different restorative materials in pulpotomized primary human molars.

The result demonstrates that none of the three filling material was free from dye penetration. Even though, nano ceramic (Ceram.x) showed the least dye penetration with a mean score of (1.20±1.03), while compomer(Twinky star) demonstrated the greatest dye penetration with mean score of (1.80±0.92), but there were no significant differences between the three studied groups.

The result data indicated no significant differences between amalgam group and Compomer(Twinky star) group, this results in agreement with Kitty et al. (23), and Mass et al. (22) who compared compomer with amalgam restorations in primary teeth, they led to the conclusion that compomer may be recommended as alternative to amalgam in primary molars. Also the results agree with Marks et al. (24) who reported a 94% success rate for compomer after 3 years, which is an annual failure rate of 2% and comparable to success rates in permanent teeth. The amalgam used achieved 88% success during the same period. Previous studies have also failed to find significant differences between amalgam and comomers in relation to restoration failures.
despite low failure rates, marginal integrity seems to be different. The findings of this study showed no significant difference between amalgam group and nano ceramic(Ceram.X) group, this in agreement with the results of Marcio et al\(^1\) who demonstrate that bonding agents and resin-based materials can exhibit excellent marginal seal for restoration of pulpotomized primary molar when compared with the amalgam. El-Kalla et al\(^1\) demonstrated that bonded resin-based materials increased the fracture resistance of primary teeth restored after pulpotomies.

Comparison between compomer(Twinky star) group and nano ceramic(Ceram.X) group, also indicated no significant difference, this may be due to the fact that both materials have a higher bond strength to enamel and dentin, better mechanical properties, higher filler content and resistance to occlusal load and low polymerization shrinkage\(^\text{(6,7,25)}\).

From this in vitro study results, compomer (Twinky star) and nano ceramic (Ceram.X) show no significance difference of dye penetration and resistance to marginal leakage compared with amalgam and can be recommended as a good alternative to amalgam for restoring primary teeth in children.

REFERENCES

Table 1: Dye penetration score (Mean±SD) for the three studied groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ±SD</th>
<th>F</th>
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<th>Sig</th>
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<tr>
<td>Amalgam</td>
<td>1.7 ±1.16</td>
<td>0.952</td>
<td>2</td>
<td>0.398</td>
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<tr>
<td>Twinky Star</td>
<td>1.8 ±0.92</td>
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<td></td>
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<tr>
<td>Ceram.X</td>
<td>1.2 ±1.03</td>
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Table 2: Percentage for score of dye penetration of the three studied groups

<table>
<thead>
<tr>
<th>Groups</th>
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<th>Twinky Star</th>
<th>Ceram.X</th>
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<tbody>
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<td>Scores</td>
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<td>%</td>
<td>No.</td>
</tr>
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<tr>
<td>3</td>
<td>3</td>
<td>30</td>
<td>2</td>
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</table>

Figure 1: Comparison of dye penetration among the three studied groups

Figure 2: Digital photograph by stereomicroscope showing score-0 dye penetration (Amalgam)

Figure 3: Digital photograph by stereomicroscope showing score-1 dye penetration (Nano ceramic (Ceram.X))

Figure 4: Digital photograph by stereomicroscope showing score-2 dye penetration (Compomer (Twinky star) group)

Figure 5: Digital photograph by stereomicroscope showing score-3 dye penetration (Compomer (Twinky star) group)