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Research Report

Microleakage of conventional, resin-modified, and nano-ionomer glass ionomer cement as primary teeth filling material

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ABSTRACT

Background: *Glass ionomer cements are one of many dental materials that widely used in pediatric dentistry due to their advantage of fluoride release and chemical bond to tooth structure. Adherence of the filling material to the cavity walls is one of the most important characteristic that need to be examined its effect on microleakage.* ***Purpose:*** *This study was conducted to examine the microleakage of nano-ionomer glass ionomer cement compared with the conventional and resin-modified glass ionomer cements.* ***Methods:*** *Standard class V cavities sized 3 mm x 2 mm x 2 mm were made on a total of 21 extracted maxillary primary canine teeth and restored with the conventional, resin-modified, dan nano-ionomer glass ionomer cements. All the teeth were immersed in a 2% methylene blue dye for 4 hours. The depth of dye penetration was assessed using digital microscope after sectioning the teeth labio-palatally. The results were statistically analyzed using Kruskal-Wallis test.* ***Results:*** *All type of glass ionomer material showed microleakage. Conventional glass ionomer cement demonstrated the least microleakage with mean score 1.29. the resin-modified glass ionomer cements (mean score 1.57) and nano-ionomer glass ionomer cement (mean score 2.57).* ***Conclusion:*** *The conventional glassionomer, resin modified glassionomer, and nano-ionomer glassionomer showed micro leakage as filling material in primary teeth cavity. The micro leakage among three types was not significant difference. All three material were comparable in performance and can be used for filling material but still needs a coating material to fill the microleakage.*

Key words: *Glass ionomer, micro leakage, primary teeth*

ABSTRAK

Latar belakang: *Semen ionomer kaca adalah salah satu dari banyak bahan gigi yang banyak digunakan dalam praktek kedokteran gigi anak karena bahan tersebut merilis fluoride dan berikatan kimia dengan struktur gigi. Perlekatan bahan tumpatan pada dinding kavitas adalah salah satu karakteristik paling penting yang perlu diteliti efeknya terhadap kebocoran mikro.* ***Tujuan:*** *Penelitian ini dilakukan untuk meneliti kebocoran mikro nano-ionomer glass ionomer dibandingkan dengan glass ionomer konvensional dan resin-modified.* ***Metode:*** *Standard kelas V kavitas berukuran 3 mm x 2 mm x 2 mm dibuat pada total 21 gigi kaninus sulung rahang atas hasil pencabutan dan ditumpat dengan glass ionomer tipe konvensional, resin-modified, dan nano-ionomer. Kemudian semua gigi direndam dalam 2% metilen biru selama 4 jam. Setelah gigi dibelah labio-palatal kedalaman penetrasi pewarna dinilai menggunakan mikroskop digital. Hasil dianalisis secara statistik menggunakan uji Kruskal-Wallis.* ***Hasil:*** *Semua jenis bahan glass ionomer menunjukkan kebocoran mikro. Glass ionomer tipe konvensional menunjukkan kebocoran mikro terendah dengan rata-rata skor 1,29; glass ionomer tipe resin-modified (rata-rata 1,57) dan glass ionomer tipe nano-ionomer (rata-rata skor 2.57). Hasil uji statistik menunjukkan kebocoran pada tepi ketiga bahan tersebut tidak berbeda secara signifikan.* ***Simpulan:*** *Bahan tumpatan glass ionomer tipe konvensional, resin-modified, dan nano-ionomer, ketiganya menunjukkan kebocoran tepi tumpatan yang tidak berbeda signifikan. Ketiga bahan yang sebanding dalam performance dan dapat digunakan untuk bahan tumpatan tapi masih membutuhkan bahan pelapis untuk mengisi kebocoran mikro yang terjadi.*

Kata kunci: *Glass ionomer, kebocoran mikro, gigi sulung*

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INTRODUCTION

Restoring carious teeth is one of the major treatment needs in pediatric dentistry. Micro leakage has been recognized as the major clinical problem in developing an ideal direct filling dental restoration.[1,2] Microleakage is defined as the chemically undetectable passage of bacteria, fluids, molecules or ions between the cavity walls and restorative materials.[3] Microleakage may be the precursor of secondary caries, may promote tooth discoloration, staining of restorative margins, an adverse pulpal response, post operative sensitivity, and even hasten the breakdown of certain filling materials.[1,2] The thickness of enamel rods in primary teeth are low compared with permanent teeth which leads to a greater possibilities of pulpal response if microleakage was created.[1,2]

Glass ionomer cements has some physical and chemical properties to make it an excellent dental restorative materials for pediatric patients. They provide a slow release of fluoride that produces a cariostatic action, chemically bind to enamel and dentin, thereby reducing the need for the retentive cavity preparation, and are compatible with pulpal tissue.[1,4] Conventional glass ionomer cements has been already used since 1970-ies, and development continued to enhance some of their physical abilities such as prolonged setting time, rough surface texture and opaqueness, and led to the introduction of resin-modified glass ionomer cement at 1990-ies.[4] To overcome the needs of surface strength, at 2008 a nano-ionomer was found, which has the same basic material with resin-modified, but added with nanofiller and nanocluster technology.[5] All of these three glass ionomer materials were usable in present, but the development was not in microleakage performance. The study was designed *in-vitro* and aimed to examine the microleakage of nano-ionomer glass ionomer cement compared with the conventional and resin-modified glass ionomer cements in primary teeth cavity.

MATERIALS AND METHODS

A total of 21 non-carious extracted primary canine with no or minimal root resorbtion were selected for the study. Surface debridement of all teeth was performed and the teeth were stored in normal saline at 4^{o} C temperature until further use. The teeth were randomly divided into three groups of 7 teeth each as follows, group A: cavities filled with nano-ionomer glass ionomer cement; group B: cavities filled with resin-modified glass ionomer cement; group C: cavities filled with conventional glass ionomer cement. A class V cavity of size was prepared on the labio-cervical surface of each tooth with no mechanical retention, using inverted diamond bur in a contra angle high-speed air motor hand piece with water coolant.

For group A, nano-glassionomer (Ketac Primer® - 3M ESPE, USA) was applied to the walls of the cavity for 15 s using microbrush, dried with an air syringe for 10 s and light cured for 10 s. An equal amount of two pastes was dispensed on a paper pad and mixed for less than 20 s. The cavity was restored; excess material removed and condensed using celluloid strip and light cured for 20 s. For group B, resin modified glassionomer (Fuji II LC® - GC Japan), dentin conditioner was applied to the walls of the cavity for 20 s using microbrush, rinsed with water spray and blotted dry with cotton pellet or air syringe. The capsule filled with restorative material was mixed using triturator for 10 s, then applied into cavity using capsule applier, and excess material removed using plastic filling covered by cocoa butter, and condensed using celluloid strip, and light cured for 20 s. For group C, conventional glassionomer (Fuji IX GP® - GC Japan), the dentin was conditioned, rinsed and dried as above. Cement was mixed and restored as above without light curing, and let the cement to set for about 2.5 minutes. All the teeth then stored in normal saline at room temperature for 24 hours (Table 1).

The apices of all the teeth were sealed with red wax and the entire tooth surface were sealed with two coats of nail

Table 1. Details of the materials investigated in the study

Grup	Material	Commercial name	Manufacturer	Packaging	Combination	Mixing
Grup A	Nano-Ionomer GIC	Ketac N100	3M ESPE, USA	Clicker dispenser	Paste-paste	Manual
Grup B	Resin-Modified GIC	Fuji II LC	GC, Japan	Capsule	Powder-liquid	Triturator
Grup C	Conventional GIC	Fuji IX GP	GC, Japan	Capsule	Powder-liquid	Triturator

varnish except for an area approximately 1 mm from the periphery of the restoration. All the teeth were immersed in 2% methylene blue dye for 4 hours. After removal from the dye solution and nail varnish, the teeth then allowed to dry. They were sectioned labio-palatally through the center of the restoration using a carborundum disk. The specimens were then studied under a digital microscope with a magnification of 25x to measure the depth of the dye penetration on the cavity walls of the teeth. The scoring was done as described by Tyas and Burrow as follows (Figure 1).[4]

Scoring for microleakage was carried out independently by one examiner for 3 times each specimen in order to escalate the validity. The scoring was performed independently by one examiner using the largest score for each specimen. Data analysis was done using Kruskal Wallis, with SPSS package 18.0.

RESULTS

Measurement with the Kruskal Wallis test was found there was no significant score differences' between all three glass ionomer materials. The microleakage scores are given in Table 2. The difference in microleakage was found in both incisal and gingival wall, but there were no significant differences between both walls. Thus, the wall with maximum scores was considered for the study. The mean score for group A- Nano-Ionomer GIC was 2.57, group B- Resin-Modified GIC was 1.57, and 1.29 for group C- Conventional GIC (Table 3).

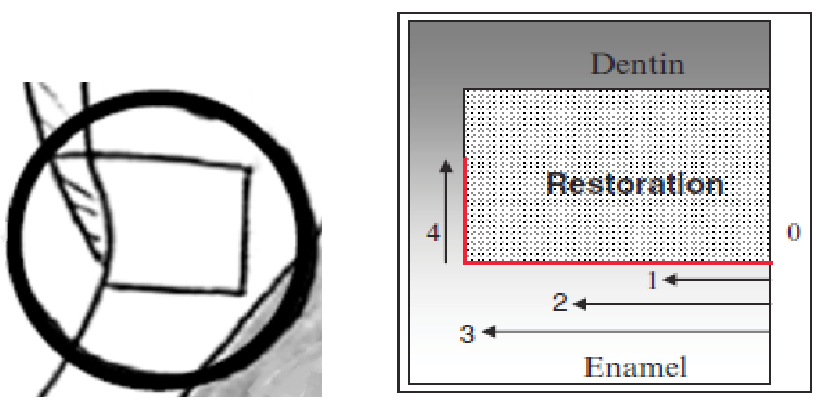
Within group C, the microleakage scores shown the least variation compared to group A and B. Score 0 was found only in group B, and score 4 found mostly in group A. Microleakage in group C did not exceed score 2. Intergroup comparison showed that there was no significant differences in microleakage between group A, B and C with P = 0.119.

Table 2 Microleakage scores of the three materials used

No. Sampel	Group A *Nano-Ionomer GIC*	Group B *Resin-Modified GIC*	Group C *Conventional GIC*
1	4	1	1
2	1	1	1
3	2	4	1
4	1	1	1
5	4	0	1
6	2	2	2
7	4	1	2

Table 3. Intergroup comparisons of mean microleakage

Group	Mean	N	Std. deviation	P-value*	Notes
A = Nano-Ionomer GIC	2.57	7	1.397	0.119	Not significant
B = Resin-Modified GIC	1.57	7	1.134		
C = Conventional GIC	1.29	7	0.488		
Total	1.81	21	1.167		



A B

Figure 1. Diagrammatic representation of the cavity showing walls (A) and scoring (B).

Notice: score 0 = no leakage; score 1 = less than and up to one-third the depth of the cavity preparation penetrated by the dye; score 2 = more than one-third and up to two-third of the depth of the cavity preparation penetrated by the dye; score 3 = more than two-third up to the junction of the axial and incisal or gingival wall but not including the axial wall; score 4 = dye penetration including the

DISCUSSION

Microleakage 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 microleakage of nano-ionomer glass ionomer cement, with conventional and resin-modified glass ionomer cement. Methylene blue dye was used to assess the microleakage as this was the simplest and fastest method. This method was also used by some researcher to evaluate the microleakage.[6,7] The result demonstrates that none of the three glass ionomer cements was free from microleakage, but nano-ionomer glass ionomer cement showed the most microleakage with a mean score 2.57, and conventional glass ionomer cement showed the least microleakage with mean score 1.29. But there were no significant differences found between those three glass ionomer materials ($p = 0.119$).

Manipulation and application process become the main concern when microleakage found in a restorative treatment. The present study showed that nano-ionomer glass ionomer cement with manual manipulation and application showed more microleakage than conventional and resin-modified glass ionomer cement. This could be caused by low condensation when filling the material into cavity, different with the conventional and resin-modified glass ionomer cement that use the capsule applicator to put the material into the cavity. Unfilled space in a cavity can lead to microleakage.[8]

The main difference in this glass ionomer cements is the basic component. Resin-modified and nano-ionomer glass ionomer cement contain resin that needs a metarcrylates polymerization to set into a restorative material. When polymerization took place, shrinkage happened in cements material, and can produce a micro gap between cavity wall and filling margins.[8,9] Nano-ionomer glass ionomer cement contains resin more than the others, and it leads to more microleakage found in this filling material. This showed that all resin-based glass ionomer material showed more microleakage than conventional glass ionomer cement. This finding is in accordance with previously reported *in vitro* study of microleakage of glass ionomer restorations.[6]

The coefficient thermal expansion of conventional glass ionomer cement is similar to that of adjacent tooth structure, which could be a reason for less microleakage compared with other two glass ionomer cements contains resin that have higher coefficient thermal expansion than tooth structure.[9] this can be the possible explanation for less microleakage in conventional glass ionomer cement compared with resin-modified and nano-ionomer glass ionomer cements. Another reason for differences in microleakage might be due to differences in maturation of setting reaction. Conventional glass ionomer cement sets faster and is of higher viscosity because if finer glass particles, anhydrous polyacrylic acids of high molecular weight and a high powder to liquid mixing ratio.[9,10]

The result revealed that although all the materials showed microleakage, conventional glass ionomer cement showed slightly less microleakage than resin-modified and nano-ionomer glass ionomer cement. The study suggested that the marginal sealing ability of nano-ionomer, resin-modified and conventional glass ionomer cement were comparable based on the mean score and percentage score of dye penetration, but conventional glass ionomer cement showed slightly better results, though the findings were statistically not significant. All of the glass ionomer material were comparable in performance and can be considered to be materials safe for usage in pediatric dentistry, as long we use a coating layer on the restoration and adjacent tooth structure to fill the micro gaps between filling material and cavity walls that can lead to microleakage.

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