BJOS Brazilian Journal of Oral Sciences

Original Article

Volume 20
2021
e213981

Comparison of microleakage of an alkasite restorative material, a composite resin and a resin-modified glass ionomer

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Received: January 15, 2021
Accepted: April 8, 2021

Editor: Dr Altair A. Del Bel Cury

Aim: To compare the microleakage of Cention N, a subgroup of composite resins with a resin-modified glass ionomer (RMGI) and a composite resin. **Methods:** Class V cavities were prepared on the buccal and lingual surfaces of 46 extracted human molars. The teeth were randomly assigned to four groups. Group A: Tetric N-Bond etch-and-rinse adhesive and Tetric N-Ceram nanohybrid composite resin, group B: Cention N without adhesive, group C: Cention N with adhesive, and group D: Fuji II LC RMGI. The teeth were thermocycled between 5°-55°C (×10,000). The teeth were coated with two layers of nail vanish except for 1 mm around the restoration margins, and immersed in 2% methylene blue (37°C, 24 h) before buccolingual sectioning to evaluate dye penetration under a stereomicroscope (×20). The data were analyzed by the Kruskal-Wallis and Wilcoxon tests (α=0.05). **Results:** Type of material and restoration margin had significant effects on the microleakage (p<0.05). Dentin margins showed a higher leakage score in all groups. Cention N and RMGI groups showed significant differences at the enamel margin (p=0.025, p=0.011), and for the latter group the scores were higher. No significant difference was found at the dentin margins between the materials except between Cention N with adhesive and RMGI (p=0.031). **Conclusion:** Microleakage was evident in all three restorative materials. Cention N groups showed similar microleakage scores to the composite resin and displayed lower microleakage scores compared with RMGI.

Keywords: Cention N, Composite resins. Dental leakage. Glass ionomer cements.

Introduction

Class V cervical carious lesions remain a major oral health problem in the elderly and those at high risk of caries[1]. A wide variety of restorative materials have been suggested for restoration of these lesions; among which, composite resins and resin-modified glass ionomer (RMGI) cements are most commonly used[1]. RMGI has been recommended for restoration of class V lesions because it has the combined benefits of chemical adhesion to the tooth substrate, fluoride release potential, and caries-preventive effect[2]. Achieving adequate marginal integrity at the dentin margins of class V restorations extending beyond the cementoenamel junction (CEJ) remains a challenge[1,3]. Secondary carious lesions develop in absence of adequate marginal seal of restorations[3]. Several factors can affect the marginal adaptation of adhesive restorative materials such as polymerization shrinkage and contraction stress[4,5], and the difference in the linear coefficient of thermal expansion (LCTE) of restorative material and that of tooth structure[6]. All these factors can lead to gap formation and marginal microleakage[4-6].

During the past two decades, researchers have extensively focused on developing dental restorative materials with improved physical and bioactive properties to minimize interfacial gap and secondary caries. Recently, a bulk-fill resin-based powder-liquid composite containing alkaline fillers (alkasite) was introduced to the market by Ivoclar Vivadent (Schaan, Liechtenstein). It is a bioactive restorative material, and the manufacturer claims that it has low polymerization shrinkage. Also, the manufacturer claims that it releases large amounts of fluoride and calcium ions at low pH and deposits minerals in the form of calcium phosphate and calcium fluoride layers. Furthermore, the hydroxide ions released from Cention N have been claimed to have a protective buffering capacity to neutralize cariogenic acids. This material can be used with or without an adhesive[7-10].

Preclinical screenings and in vitro studies simulating oral conditions are useful for estimation and predication of the performance of restorative materials. Various in vitro methods are used for evaluation of marginal quality of restorations such as penetration test in class II and V cavities and assessment of marginal interface under a light microscope or a scanning electron microscope. Dye penetration test is still the most commonly used method for evaluation of the sealability of restorative materials. Various types of dyes can be used for this purpose. No specific dye tracer has been recommended by the ISO standard for this test. The most commonly used dyes for this test include basic fuchsine, methylene blue, and silver nitrate. Thermocycling (TC) and/or mechanical loading have been recommended for microleakage tests to better simulate the clinical conditions[11].

The available studies about the microleakage mostly compared the conventional GICs rather than the RMGIs with Cention N[12-14]. Cention N is a resin-based (UDMA-based) material containing fillers. RMGIs contain resin and their composition is more similar to alkasite restorative materials than conventional GICs[7,9,10]. In addition, the frequency of thermal cycles in previous studies on this topic was 500 or less while 500 cycles are the minimum cycles recommended by ISO 11405[15].

The aim of this study was to evaluate the effect of three restorative materials namely an alkasite restorative material (Cention N®; Ivoclar Vivadent, Schaan, Liechtenstein) with and without an adhesive (Tetric® N-bond Vivadent, Schaan, Liechtenstein), a nanohybrid composite resin (Tetric-N® Ceram, Ivoclar Vivadent, Schaan, Liechtenstein), and a RMGI (GC Fuji II LC®, GC Corporation., Tokyo, Japan) on the marginal integrity of class V restorations submitted to 10,000 thermal cycles using the dye penetration test. The null hypotheses were that the location of restoration margin (in the enamel or dentin) or type of restorative material would have no significant effect on the marginal microleakage of restorations.

Materials and Methods

The commercial materials used in this study and their composition are presented in Table 1. The materials were used according to the manufacturers' instructions. The study was approved by the Ethics Committee in Research of School of Dentistry of Tehran University of Medical Sciences (IR.TUMS.DENTISTRY.REC.1398.055).

Table 1. The materials used and their classification, manufacturer, and composition[6,8,29,30]

Material (manufacturer)	Liquid	Powder	Batch number
Cention® N (Ivoclar Vivadent, Schaan, Liechtenstein)	UDMA, DCP, Aromatic aliphatic-UDMA PEG-400 DMA	Ca-F-Silicate glass, Ba-Al silicate glass, Ca-Ba-Al fluorosilicate glass, YtF3, isofiller (78.4 wt%)	W07418
GC Fuji II LC® (GC Corp., Tokyo, Japan)	Polyacrylic acid, HEMA, 2,2,4 TMHEDC, TEGDMA	Fluoro-alumino-silicate glass	1704011
Tetric® N-Ceram (Ivoclar Vivadent, Schaan, Liechtenstein)	Bis-GMA, Bis-EMA UDMA	Ba glass; YbF3; mixed Oxide; prepolymer (80%wt%)	W84901
Tetric® N-Bond (Ivoclar Vivadent, Schaan, Liechtenstein)	Bis-GMA, UDMA, HEMA, Phosphonic acid acrylate, ethanol, nanofiller, catalysts and stabilizer, nanofiller		W83533

UDMA: Urethane dimethacrylate; DCP: Tricyclodecan-dimethanol dimethacrtylate; An aromatic aliphatic-UDMA: Tetramethyl-xylylen diurethane dimethacrylate; PEG-400 DMA: polyethylene glycol 400 dimethacrylate; Ca-F-Silicate glass: Calcium fluorosilicate glass; Ba-Al silicate glass: Barium aluminum silicate glass; Ca-Ba-Al-F glass: Calcium barium aluminum fluorosilicate glass; YtF3: Ytterbium trifluoride; Isofiller: Copolymer, HEMA: Hydroxyethyl methacrylate; 2,2,4 TMHEDC: Trimethyl hexamethylene dicarbonate; TEGDMA: Triethylene glycol dimethacrylate; Bis-GMA: bisphenol A diglycidylether methacrylate; Bis-EMA: ethoxylated bisphenol-A dimethacrylate; Ba glass: Barium glass.

Specimen preparation

Forty-six sound, non-carious, unrestored human third molars, extracted for periodontal reasons or as part of orthodontic treatment, were collected after informed consent was obtained from the patients. The minimum sample size for each study group was calculated to be 23, based on a previous study[12] considering α=0.05, β= 0.2 and pooled standard deviation of 2.1 using SPSS 11 (SPSS Inc., Chicago, IL). The teeth were debrided of residual plaque, calculus and residual soft tissue, and stored in a solution of distilled water and 0.5% chloramine T at 4°C until usage. All teeth had been extracted within the past 3 months. The teeth were visually inspected under a stereomicroscopic at ×10 magnification (Leica, LEICA EZ4D, MEL SOBEL Microscopes, Italy), and sound teeth without fracture lines and cracks were selected for this study. Class V cavities (with 3 mm occlusogingival width, 3 mm mesiodistal width, and 1.5 mm depth) were prepared in the buccal and lingual surfaces of each tooth using a cylindrical diamond bur (≠ 838-012-FG; Hager & Meisinger GmbH, Neuss, Germany) and a high-speed handpiece under copious water irrigation. The occlusal margin of the cavities was located 2 mm coronal to the CEJ, while the gingival margin was located 1 mm apical to the CEJ. The diamond bur was replaced after five preparations. Non-retentive cavities with divergent walls were prepared as such. All the internal line-angles were rounded. The dimensions of all cavities were measured using a periodontal probe.

Restorative procedure

Before restoration, the prepared cavities were gently cleaned with a slurry of pumice paste and water using a prophy cup, and thoroughly rinsed with tap water. The prepared teeth were randomly divided into four groups (n=23) according to the type of material used, as follows:

Group A: (composite resin):

37% phosphoric acid gel (Ivoclar Vivadent, Schaan, Liechtenstein) was applied on the enamel and subsequently on the dentin margins for 15 s. Afterwards, the etchant was thoroughly rinsed off with water spray for 15 s, and the excess water was removed with a small cotton pellet to avoid excessive drying. Tetric-N Bond nanofilled single-component adhesive (Ivoclar Vivadent, Schaan, Liechtenstein) was applied in one thick layer and rubbed on the enamel and dentin surfaces with a micro-applicator brush for 10 s. Excess adhesive in the line angles and the solvent were removed by gentle air stream for 10 s. The adhesive was light-cured for 10 s using a light-emitting diode (LED) curing unit with a light intensity of 1200 mW/cm^2 (Bluephase; Ivoclar Vivadent, Schaan, Liechtenstein). Light output was measured using a radiometer (Bluephase Meter II, Ivoclar Vivadent AG, Schaan, Lichtenstein). A2 shade of Tetric-N Ceram nanohybrid composite resin (Ivoclar Vivadent, Schaan, Liechtenstein) was used to restore the cavities in two layers with oblique incremental application technique. The first oblique layer was applied and extended from the gingival floor to the axial wall. The second increment was applied to fill the remainder of the cavity. Each layer was polymerized with LED curing unit (Bluephase, Ivoclar Vivadent, Schaan, Liechtenstein) for 20 s.

Group B: (Cention N without adhesive)

This product is only available in A2 shade. The prepared cavities were gently dried with air stream. One spoon of powder and one drop of liquid were dispended on a mixing pad according to the manufacturer's instructions. The powder was gradually added to the liquid and thoroughly mixed for 60 s until a homogenous mass with a slight shine was obtained to wet the tooth substrate. The restorative material was immediately applied and condensed in the cavity with a spatula in one increment. Excess material was carefully removed, and the restoration was cured for 20 s using a LED curing unit.

Group C: (Cention N with adhesive)

The same steps were followed for adhesive application in this group as in group A. Cention N was then mixed and delivered into the cavity with the same sequence as in group B.

Group D: (RMGI)

A2 Vita shade of RMGI was chosen. The cavities were conditioned with 10% polyacrylic acid (Dentin Conditioner, GC Corporation, Tokyo, Japan) applied with a micro-applicator brush for 20 s, and were then thoroughly rinsed with water spray for 20 s and blot-dried with cotton pellets to avoid desiccation. One level scoop of powder and two drops of liquid were placed on a mixing pad according to the manufacturer's instructions. The powder was divided by half and mixed with the liquid within 25 s until a homogenous mass was achieved and applied and packed in bulk into the cavities with a spatula as long as the surface of the mixed cement was shiny. Afterwards, it was polymerized for 20 s using a LED curing unit.

All restored cavities were stored in distilled water at 37°C for 24 h, and were then finished and polished with graded series of Sof-Lex discs (3M ESPE, Dental products St Paul, MN, USA). The same operator prepared all the specimens.

Microleakage test

The specimens were thermocycled for 10,000 cycles between 5˚ C and 55˚C with a dwell time of 30 s and a transfer time of 10 s. Following TC, the teeth were dried, and the root apex of each tooth was sealed with sticky wax. The entire tooth surface including the crown and root structures were covered with two layers of nail varnish, except for a 1 mm band around the restoration margins.

All the specimens were then immersed in freshly prepared 2% methylene blue solution for 24 h at 37°C. The teeth were then rinsed with running water. Afterwards, the specimens were mounted in auto-polymerizing acrylic resin (Acropars, Marlic Medical Co., Tehran, Iran) and longitudinally sectioned in half at the center of the restoration in buccolingual direction with a low-speed diamond saw under water coolant. The sectioned teeth were evaluated under a stereomicroscope (Leica, LEICA EZ4D, MEL SOBEL Microscopes, Italy) at ×20 magnification. The extent of dye penetration at the restorative material-tooth interface was scored from zero to three along the occlusal and cervical walls[13](Figure. 1). The dye penetration scores were determined by one single operator who was blinded to the type of restorative material used for each group.

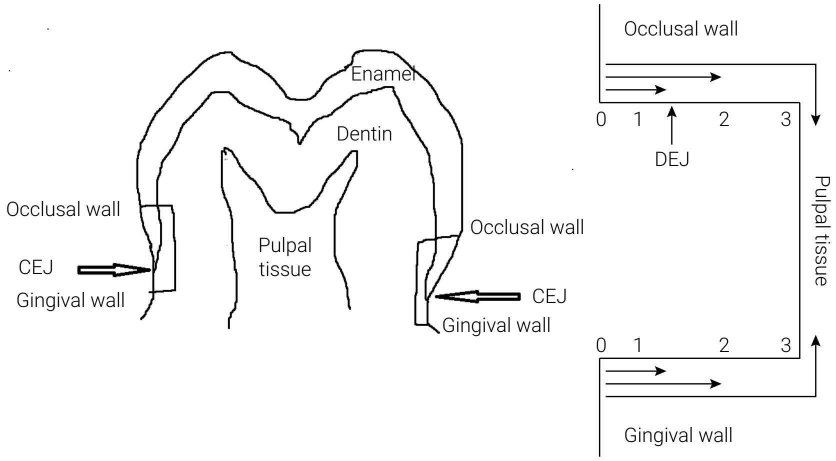

Figure 1. Schematic view of the cavity prepared in the buccal and lingual walls of a molar tooth. The maximum degree of dye penetration was recorded according to the followiing scoring system :0, no dye penetration; 1, dye penetration to 1/3 of the cavity wall; 2, dye penetration up to 2/3 of the cavity wall, 3, dye penetration extending to the axial wall and beyond. CEJ: Cementoenamel junction; DEJ: Dentinoenamel junction

Score 0: No dye penetration

Score 1: Dye penetration extending to 1/3 of the occlusal or cervical wall

Score 2: Dye penetration extending to two-thirds of the occlusal or cervical wall

Score 3: Dye penetration extending to the axial wall and beyond

Statistical analysis

The statistical analysis of microleakage data was performed using SPSS version 25 (SPSS Inc., Chicago, IL, USA). The Kruskal-Wallis test was applied for multiple comparisons followed by the Dunn test. The occlusal and gingival microleakage scores were compared using the Wilcoxon signed rank test. Level of significance was set at 0.05 for the main analysis, and Dunn adjusted p-values were used for multiple comparisons.

Results

Table 2 presents the microleakage scores (number and percentage) at the enamel and dentin margins of the four groups. The microleakage scores at the enamel margin were significantly lower than the corresponding values at the dentin margins in all groups ($p<0.001$).

Table 2. Microleakage (number and percentage) of the study groups at the enamel and dentin margins and pairwise comparison

	Material	Enamel Number/percentage					Dentin Number/percentage				
		0	1	2	3		0	1	2	3	
A	Tetric N-Ceram	14(61%)	8(34%)	1(4%)	0	ab	1(4.34%)	3(13%)	2(8.6%)	17(73.9%)	cd
B	Cention N without adhesive	18(78%)	5(22%)	0	0	b	1(4.34%)	1(4.34%)	4(17.39%)	17(73.9%)	cd
C	Cention N with adhesive	19(83%)	4(17%)	0	0	b	3(13%)	3(13%)	8(34.8%)	9(39%)	c
D	RMGI*	12(25%)	6(26%)	3(13%)	2(8.6%)	a	0	2(8.6%)	3(13%)	18(78%)	d
		P value=0.041					P=0.020				

Similar letters show that the distribution of the leakage scores are not significantly different.
*RMGI: Resin-modified glass ionomer

The Kruskal-Wallis test indicated significant differences between the restorative materials for the occlusal and gingival margin microleakage scores (p=0.041 for the enamel margins, and p=0.020 for dentin margins). Table 2 shows pairwise comparisons of the differences in the microleakage scores of the study groups at 0.05 level of significance. The only significant differences at the enamel margins were found between Cention N with/without adhesive and RMGI groups (p=0.011 and p= 0.025, respectively). However, no significant difference was found between the other groups (p≥0.121). There was no statistically significant difference in microleakage between the groups at dentin margins (p≥0.076), except for Cention N with adhesive and RMGI (p=0.031).

Discussion

The purpose of this in vitro study was to compare the microleakage of different types of restorative materials for restoration of class V cavities in the cervical region of the teeth using the dye penetration test. Furthermore, microleakage scores of Cention N cavities restored with or without adhesive were compared. The recommended adhesives by the manufacturer of Cention N product are either universal bonding agents such as Tetric N-Bond Universal or etch and rinse adhesive systems such as Tetric N-Bond[8]. In the current study the latter surface treatment was selected to compare the microleakage scores since the phosphoric acid agent removes the smear layer[13].

Based on the results of the present study, the score of microleakage was greater at the dentin margin than the enamel margin in all groups regardless of the type of restorative material used. Thus, the first null hypothesis of the study was rejected. With regard to the type of restorative material, the results of the present study showed significant differences between Cention N and RMGI after immersion in 2% methylene blue for 24 h. Therefore, the second null hypothesis regarding insignificant effect of type of restorative material on microleakage score was also rejected.

The tooth samples were exposed to 10,000 thermal cycles corresponding to 1-year of clinical service in the oral cavity, as claimed by Gale and Darvell. TC simulates the thermal alterations in the oral cavity that lead to stress build-up at the interface and can adversely affect marginal integrity of the restoration, causing microleakage. TC was performed between 5-55 ˚C according to ISO11405[14,15].

The results of the present study regarding lower microleakage at the enamel margins were similar to the findings of a previous study[16]. Bonding of adhesive restorative materials to dental substrate depends on either micromechanical interlocking and hybridization due to the penetration of bonding resin into the microscopic porosities on the surface of enamel and dentin, or chemical interactions with the inorganic content of dental substrate. Both mechanisms depend on the amount of surface free energy of dental substrate, which is directly proportional to the mineral content of the tooth structure and inversely correlated with the percentage of organic content. Enamel has a more homogenous structure than dentin due to higher mineral content and lower water and organic content. Therefore, one primary requisite for better marginal seal is already provided[17,18].

The comparison between RMGI and Cention N showed that Fuji II LC group revealed significantly higher leakage scores at the enamel margins compared with Cention N groups with/without adhesive. Dentin margins in class V cavities restored with Fuji II LC showed significantly higher leakage scores than Cention N group with adhesive. There are several factors that may explain these findings such as viscosity, polymerization rate, monomer conversion and linear coefficient of thermal expansion (LCTE).

There is an inverse relationship between viscosity of a resin-based material and its rate of polymerization[19]. It has been demonstrated that powder/liquid (P/L) ratio of a resin-based cement affects its viscosity. Higher P/L ratio leads to higher viscosity[20]. Viscosity also depends on the filler loading, size (and hence the surface area), and shape of fillers as well as the heterogeneity of particle sizes and monomer types in the mixture. It was demonstrated that decreasing the filler size increased the viscosity of experimental composites[19]. The recommended P/L ratio for Cention N is 4.6:1, which is higher than that of Fuji II LC (3.2:1)[20]. The average particle size of Cention N is between 0.1 µm and 35 µm[8], a wide size distribution; while, that of Fuji II LC is 5.9 µm[21].

Considering the abovementioned explanation, Cention N appears to have higher viscosity. High viscosity decreases the mobility of free radicals, leading to a reduction in polymerization rate, which has a great impact on shrinkage stress relief and interfacial gap reduction[4,5,19]. Therefore, the authors assume that lower microleakage scores in Cention N groups compared with the RMGI group might be explained by its probably lower rate of polymerization. Furthermore, it has been stated that lower particle content can cause higher volumetric shrinkage[4]. Therefore, it might be assumed that Fuji II LC with lower P/L ratio can undergo higher volumetric shrinkage and contraction stress, that can cause interfacial debonding and higher leakage scores.

Also, a direct correlation exists between the degree of polymerization and volumetric shrinkage[4,5]. It also has been demonstrated that monomers with lower molecular weight and viscosity and higher mobility have higher degree of monomer conversion[22]. UDMA and HEMA are the base monomers of Cention N and Fuji II LC, respectively[6,8,23]. UDMA has higher molecular weight and viscosity than HEMA[22]. As a result, higher degree of conversion is expected in Fuji II LC. Panpisut and Toneluck found the same results[20]. This is another factor which might explain higher leakage scores in Fuji II LC group.

LCTE is another parameter influencing the volumetric change of restorative materials in the oral cavity. If the difference between the LCTE of the tooth substrate and that of a restorative material is high, marginal seal at the tooth substrate-restoration interface might be breached[6]. Pinto-Sinai et al. explained that LCTE of resin-based restorative materials is influenced by the amount of filler. RMGI cements do not contain fillers[6]. Cention N has 78.4% filler content by weight in the final mass[8,23], and a higher P/L ratio than Fiji II LC[20], which might decrease its LCTE. It has been shown that Fuji II LC has a high LCTE during heating and cooling cycles (15ºC-50ºC) i.e. 25.4 and 30 ppm, respectively. The LCTE of dentin and enamel is 11 and 17 ppm, respectively in this temperature range[6]. The LCET of molar teeth in the cervical region has been reported to be around 5 ppm[24]. In the current study, the difference in expansion and contraction at the tooth and RMGI interface might have caused marginal deterioration and higher leakage score in the RMGI group, compared with CN groups.

RMGI and composite resin displayed no difference in leakage score in the current study. The bonding of composite resin to tooth structure is mediated by micromechanical adhesion following etching of dental substrate and penetration of bonding resin[17]. The bond strength of composite resin to tooth structure is higher than that of RMGI[18]. an interfacial gap is expected if the adhesion of the restorative material to the tooth structure does not compensate for the shrinkage stress induced during setting and polymerization[4,5]. Similar leakage scores of these two materials can be explained by several properties of the materials such as their modulus of elasticity, hygroscopic expansion, and the application technique of the material.

RMGI has lower modulus of elasticity than composite resin[25], which can relieve the induced polymerization shrinkage stress. A material with low modulus of elasticity has higher capacity for plastic flow and stress relaxation during polymerization[4,5]. Studies have shown that both composite resins and RMGI cements absorb water[26,27]. In the humid oral environment, polymerization shrinkage may be partly relieved by hygroscopic expansion following water sorption. Therefore, marginal gaps caused by polymerization shrinkage can be decreased by hygroscopic expansion[26,27]. Water uptake by a restorative material is a diffusion-controlled process through the resin matrix. The diffusion coefficient of water sorption is controlled by hydrophilicity/hydrophobicity of the resin matrix and filler level/resin content ratio[27,28]. Panpisut and Toneluck showed that the studied nanofilled composite resin had lower water sorption than Fuji II LC, and they attributed this finding to the hydrophilic nature of resin matrix (HEMA) and polyacrylic salt network in the studied RMGI cement[20]. HEMA accounts for nearly 25%-50% of the liquid content of Fuji II LC[6]; while, more hydrophobic and rigid monomers such as Bis-GMA and UDMA comprise the polymer network of Tetric N-Ceram[29]. The filler content of the composite is 80-81% by weight[29]; while, Fuji II LC has no filler content[6]. Furthermore, there is a relationship between the cement maturity and water balance. Acid-base reactions in light-cure RMGI are slower than photo-initiated polymerization[25]. Thus, a longer time for water uptake and maturation is required, and the maturation occurs over a prolonged period of time. However, lower post-curing is expected to occur in composite resin, and the majority of monomer to polymer conversion reactions possibly occur upon the initial light irradiation. This means that composite resin is close to maturity. All these factors probably cause higher water sorption in RMGI than resin composite[25]. Several studies found that water exposure of RMGI cements and consequent hygroscopic expansion were beneficial for reversing tensile or pulling stresses into compressive stress to minimize gaps in teeth restored with resin-based materials[26,27]. Furthermore, the composite resin was placed in two oblique increments to avoid contact with the opposing occlusal and gingival margins at the same time. The rational was that this technique decreases the overall polymerization shrinkage and consequently the polymerization stress[4,5]. Incremental application is also helpful to reduce the probability of bond failure along the gingival margins located in dentin. Dentin provides a weaker bond compared with enamel[17], and polymerization shrinkage in one increment may cause debonding at the weaker interface.

Composite resin and Cention N groups with/without adhesive also showed comparable leakage scores. This finding could be attributed to degree of conversion (DC), polymerization shrinkage and contraction stress of these materials.

Degree of polymerization and polymerization stress are related to interfacial gap formation[4,5]. DC is influenced by the filler/resin ratio and resin content. The former factor for the composite resin and Cention N is relatively the same (Table 1). However, they do not contain the same resin content (Table 1). Tetric N-Ceram is a Bis-GMA-based composite resin[29]; while, Cention N is a UDMA-based polymer[7,8]. Bis-GMA monomer has higher molecular weight and viscosity but lower DC than UDMA monomer[22]. Panpisut and Toneluck[20] found a higher monomer conversion in Cention N compared with a Bis-GMA nanofilled composite resin. Therefore, Cention N is expected to have higher microleakage score. However, there are other factors that might compensate for the higher DC, and consequent polymerization shrinkage and contraction stress. Ilie[23] showed that Cention N polymerization initiates instantly following light irradiation in 2 mm material thickness and reaches a plateau in 1 h; whereas, composite resin polymerization continues for more than 24 h. This polymerization behavior might explain the similar leakage scores in these two groups.

It was interesting that cavities restored by Cention N with or without adhesive did not reveal significant differences in leakage scores. It shows that marginal adaptation of cavities restored with this material is unrelated to micromechanical retention provided by the adhesive resin. According to the manufacturer and several authors, it is a self-adhering bulk fill restorative material that obviates the need for a separate adhesive[7-9]. The improved adaptation of the material to tooth margins and smear layer might be related to its hydrophilic character and its ability to wet the tooth surface which is attributed to its resin composition containing a hydrophilic dimethacrylate (polyethylene glycol dimethacrylate)[8,10] (Table 1).

In summary, Cention N with and without adhesive showed comparable leakage scores to the composite resin, and the values were lower than those in Fuji II LC. Tetric N-Ceram nanohybrid composite resin, which was incrementally applied on the tooth substrate showed similar leakage scores in comparison with Cention N groups and RMGI.

Comparison of the abovementioned commercial materials is not simple. There are many factors related to different formulations of resin polymers that complicate a precise comparison such as the initiator type and concentration, and filler dispersion that can affect the physicochemical properties. In addition, thermomechanical loading can better simulate the harsh oral environment and its adverse effect on the longevity of restorations. Therefore, future studies are required on other properties of materials such as their DC, polymerization shrinkage, shrinkage stress, volumetric shrinkage, elastic modulus, and water sorption after thermomechanical cycling of specimens to provide more detailed information and explain the variations in data.

Conclusions

In vitro microleakage of Cention N was comparable to Tetric N-Ceram at enamel and dentin margins. However, Cention N showed significantly lower leakage scores than Fuji II LC.

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