AJDS ALAZHAR
Al-Azhar Journal of Dental Science
Vol. 26- No. 1- 107:112- January 2023
Print ISSN 1110-6751 | online ISSN 2682 - 3314
https://ajdsm.journals.ekb.eg
Orthodontic & Pediatric Dentistry Issue *(Orthodontics and Pediatric Dentistry)*

INFLUENCE OF THREE DIFFERENT CURING DEVICES ON MICROLEAKAGE OF TWO FLUORIDE-CONTAINING RESIN-BASED RESTORATIVE MATERIALS

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ABSTRACT

Objective: Microleakage of the resin-based restorative materials has marked effect on the success of the restoration, and it depends on various factors including the type of restorative material and the curing device. Hence, this study was to assess the influence of three different curing devices on the microleakage of two resin-based restorative materials in anterior primary teeth. **Material and methods:** A total of thirty primary anterior teeth were used in this study in acrylic mold. Class V cavities were ideally prepared and restored with two resin-based restorative materials (resin-modified glass ionomer cement (RMGIC) - GC Fuji LC™ - Japan , and GIOMER - Beautifil Flow Plus™ - Japan) according to the manufacturer's instruction. The restored teeth were divided into two equal main groups (n= 15) according to the type of resin restorative material as follow; Group A; teeth restored with RMGIC. Group B; teeth restored with GIOMER. Then, the samples of each main group were then subdivided into three equal subgroups (n=5) according to the type of the curing system (Quartz tungsten Halogen (QTH) light curing, Light emitted diode (LED) curing, and Argon laser). The restored teeth with class V cavities were subjected to a thermocycling (Julobo Ft 200, Germany) (500 cycles between 5°C - 55°C for 60 seconds each with a dwell time of fifteen sec, simulating 5-months of clinical exposure in the oral cavity) and were then evaluated for microleakage via the silver nitrate tracer penetration method. **Results:** The statistical analysis of microleakage results of RMGIC and GIOMER restorative materials cured with QTH, LED, and Argon laser-curing devices revealed that; the difference in microleakage was statistically non-significant as indicated by Mann Whitney U Test. **Conclusion:** All light curing units used in this study have no effect on microleakage of RMGIC and Giomer. The least microleakage occurred around the RMGIC group and the maximum microleakage was seen in GIOMER group. Also, the results revealed that Argon laser has lower scores value of microleakage when compared to QTH and LED LCUs.

KEYWORDS: Microleakage, Resin-modified Glass Ionomer, GIOMER, Light-curing systems, Argon Laser

INTRODUCTION

Tooth caries is one of the commonest childhood chronic diseases that affect the primary teeth especially during mixed dentation, although it is commonly preventable and/or curable [(1)]. Fluoride-containing restorative materials have the ability to release the fluoride which enhance the caries resistance of tooth through various protective mechanisms including; inhibition of demineralization ability and enhances remineralization ability, as well as it plays a significant role in the inhibition of microbial growth of cariogenic bacteria [(2,3)].

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DOI: *10.21608/ajdsm.2022.118286.1296*

Also, these materials have higher recharging ability with fluoride when subjected to different fluoridated products such as; toothpaste, mouthwashes, or topical fluoride[1,4]. This recharging ability with fluoride may devote to their effectiveness in caries prevention for long-term during clinical use[4].

The conventional glass ionomer cement (CGIC) is the commonest restorative material that has the ability to releasing fluoride, and emerge tops amongst the restorative materials because of their effectiveness in prevention of the secondary caries around site of restorations[5]. However, they have lower physical and mechanical properties in comparison with composite resins including high initial moisture sensitivity, solubility, inferior mechanical properties, and lower translucency [6].

To overcome the inherit disadvantages of the CGIC while maintaining its clinical advantage of fluoride-release and caries inhibition, hybrid materials were developed that stated to merge the benefits of conventional GIC (fluoride release) and composite resins (better mechanical durability) [7]. Examples of these hybrid materials include; RMGIC, polyacid-modified composite resins (compomers), and GIOMER [4,7].

The curing of resin-based materials with light-curing units (LCUs) is considered an intrinsic part of modern restorative dentistry[8]. There are different LCUs in the dental clinic including; QTH, LED[9]. Recently, LASER curing devices such as Argon laser has been accepted for launch the polymerization reaction of the “visible” light cured-resins [8,10].

However, the efficient polymerization performance of these LCUs is a essential factor in assertive optimal performance during clinical service of these resin restorative materials [11,12]. Inadequate curing of these resin-based restorative materials can associate with various clinical problems such as; inferior mechanical characteristics, and higher microleakage and hence incidence of recurrent carries and pulpal irritation [8,13].

Thus, this in vitro study investigated the effect of Argon laser, QTH, and LED curing systems on the microleakage of two fluoride-containing resin restorative materials.

Study design:

Prospective in vitro comparative study

Inclusion and exclusion criteria:

Inclusion criteria include Primary anterior teeth, Non-carious anterior primary teeth, free from cracks or any developmental defects, Primary teeth without fluorosis and Primary teeth extracted due to physiological exfoliation.

Exclusion criteria include Permanent anterior teeth, Carious or cracked anterior primary teeth, Primary teeth charged with fluoride and Primary teeth extracted due to trauma.

MATERIAL AND METHODS

Sample Preparation

Thirty normally exfoliated primary anterior teeth were collected from children attending in the Outpatient Clinic of Pedodontics Department, Faculty of Dental Medicine, Al-Azhar University. In the cervical third of each tooth standard class V cavity (non-beveled) with dimensions of 3 mm wide, 2 mm length, and 1 mm depth (by Vernier manual caliper, France) was prepared following the guidelines for resin composite cavity preparation using a high-speed handpiece with diamond bur [3].

The cavity was then etched with phosphoric acid (37%) for 20 sec, then cleaned with water spray and air-dried for another 5 sec. After that, the adhesive was applied and light cured and the cavity was restored with either RMGIC or GIOMER (n=15) according to the manufacturer’s instructions [8,14]. The restorations were covered with polyester strip and then light-cured with the light-guide-tip 1-mm away from this polyester strip [14].

Subject Grouping:

The restored teeth were divided into two equal main groups (n= 15) according to the type of resin restorative material as follow; Group A; teeth restored with RMGIC. Group B; teeth restored with GIOMER. Then, the samples of each main group were then subdivided into three equal subgroups (n=5) according to the type of the curing system QTH light curing, LED curing, and Argon laser.

Microleakage evaluation:

The restored teeth with class V cavities were then subjected to a thermocycling (Julobo Ft 200, Germany) 500 cycles between 5°C - 55°C for 60 seconds each with a dwell time of fifteen sec, simulating a 5-months of clinical exposure in the oral cavity and were then evaluated for microleakage via the silver nitrate tracer penetration method by soaking of the teeth in 50 % silver nitrate solution for 8 hours in the dark (8,13).

To prevent leakage of silver nitrate solution through the teeth, they were painted from all directions with 2-layers of nail-resin varnish, leaving only a window of 2-mm around the restoration (8,15). Then, the apical portion of the teeth were sealed with modeling wax (15). The teeth were then, sectioned in a buccolingual direction using a water-cooled diamond and then polished. The samples were then soaked in photo-developer for 8-hours, followed by another 16-hours of fluorescent light exposure. The samples were then examined with MA 100 Nikon steriomicroscope Japan with Omnimet image analysis software 30X magnification (8). The tracer of silver nitrate penetration was distinguished by its blackening effect on tooth hard tissues and each sample was given a microleakage (trace penetration) score according to the following criteria;

- 0; No tracer penetration.
- 1; Tracer penetration to 1/4 of the cavity depth.
- 2; Tracer penetration to 1/2 of the cavity depth.
- 3; Tracer penetration to 3⁄4 of the cavity depth.
- 4; Tracer penetration reaching the cavity floor

RESULTS

The statistical analysis of microleakage results of RMGIC and GIOMER restorative materials cured with QTH, LED, and Argon laser curing devices revealed that; the difference in microleakage was statistically non-significant as indicated by Mann Whitney U Test (Table 1 and 2). The results of the present study, found that the least microleakage occurred around the RMGIC group and the maximum microleakage was seen in GIOMER group. Also, the results revealed that Argon laser has lower scores value of microleakage when compared to QTH and LED LCUs (Figure 1).

TABLE (1) Comparison of RMGIC microleakage with the different curing methods:

Microleakage	QTH; n (%)	LED; n (%)	Laser; n (%)
Score 0	8 (40%)	10 (50%)	10 (50%)
Score 1	4 (20%)	5 (25%)	6 (30%)
Score 2	4 (20%)	3 (15%)	3 (15%)
Score 3	2 (10%)	1 (5%)	1 (5%)
Score 4	2 (10%)	1 (5%)	0 (0%)
Comparison by	H-value= 0.14		
p-value	0.93239^{ns}		

; The result is significant at p < 0.05.
; ns= non-significant.

Table(2) Comparison of Giomer microleakage with the different curing methods:

Microleakage	QTH; n (%)	LED; n (%)	Laser; n (%)
Score 0	3 (15%)	4 (20%)	5 (25%)
Score 1	6 (30%)	8 (40%)	8 (40%)
Score 2	6 (30%)	4 (20%)	3 (15%)
Score 3	3 (15%)	3 (15%)	3 (15%)
Score 4	2 (10%)	1 (5%)	1 (5%)
Comparison by	H-value= 0.02		
p-value	0.99005^{ns}		

; The result is significant at p < 0.05.
; ns= non-significant.

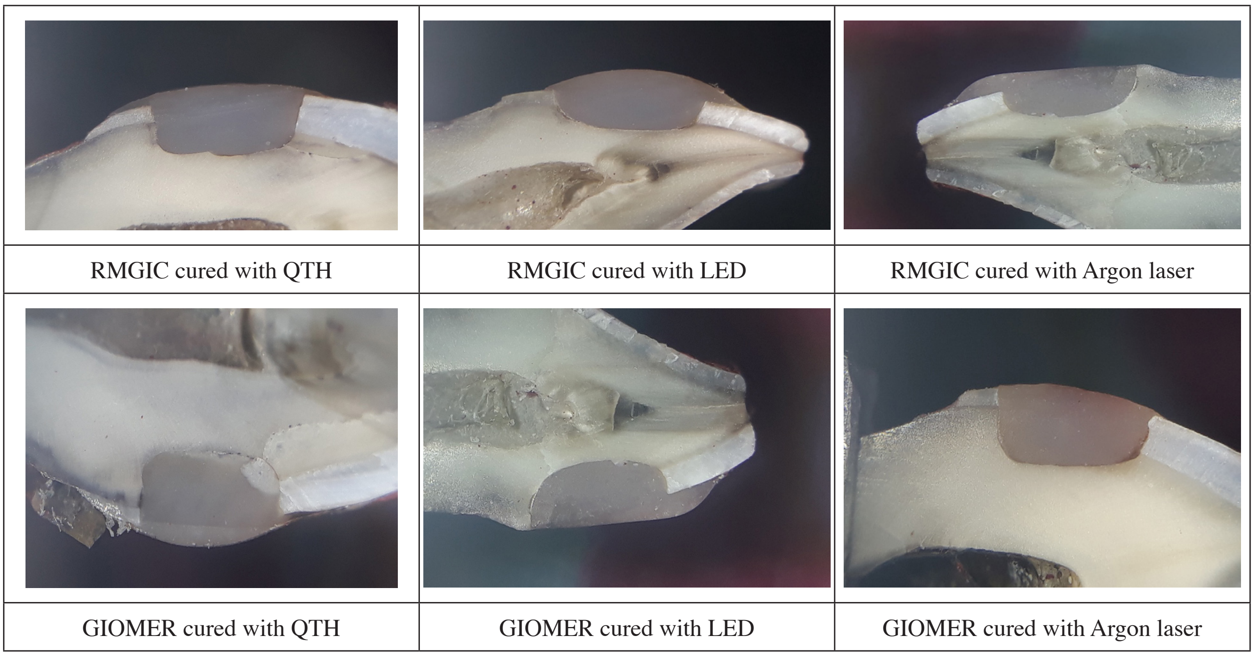

Figure 1: Photographs showing microleakage from RMGIC and GIOMER with the different curing methods.

DISCUSSION

In the current study RMGIC and GIOMER were select as alternative restorative materials to overcome the disadvantages of the CGICs while maintaining their good clinical benefit in fluoride release and caries prevention, as these hybrid materials apparently merge the benefits of both composite and GIC [7]. Also, the primary teeth extracted for orthodontic purposes, were used in this study as the density of mineralized tooth structures were influenced by the tooth age, where the older tooth age, the more of its mineral content [16]. While, the selection of caries, and crack free primary teeth as test samples in this study was to avoid bias use of damaged hard substances during microleakage test[17,18].

The QTH, LED, and Argon laser were chosen as light-curing units for polymerization of RMGIC and GIOMER as resin-based restorative materials. This because adequate polymerization efficiency of these curing units which is a determinable factor in the optimal performance of these resin-based materials[11,12]. However, improper polymerization of these resin-based materials can associate with various clinical problems such as; inferior mechanical characteristics, and higher microleakage and hence incidence of recurrent carries and pulpal irritation[8,13].

Moreover, in the present study the complete coating of tooth surfaces by using resin nail varnish prior to microleakage test to avoid the misleading results, since silver ion traces may penetrate the tooth hard substance during the soaking in the silver-nitrate solution. Thus, the leakage score that recorded was only because of interactions between RMGIC or GIOMER and method of curing [19]. Thermocycling was performed before the microleakage test in this study to simulate the cyclic flexure of tooth in these cervical areas along with adhesive material which may lead to loss of marginal integrity [20].

In the current study, silver nitrate tracer was used rather than dye of methylene blue. This because silver traces considered aggressive test due to the relatively small size of the silver ions (0.059 nm) and thus their higher penetration capacities[13,19]. Moreover, the microleakage of class V cavities usually performed in vitro to predict the clinical performance of the tested restoration[20]. As the coronal margins of these class V cavities are in enamel while the gingival margin is usually located in cementum or dentin [21]. Also, class V cavities were selected for this study because of its configuration or "C" factor. The "C" factor of class V restoration is, which is the reason for the internal bond disruption as well as micro-cracks around the cavity walls and restorations, so microleakage evaluation is critical in class V cavities due to this high C factor [18].

According to the results of the present study, we found that the least microleakage occurred around the RMGIC group and the maximum microleakage was seen in GIOMER group. However, the results of present study revealed no significant difference in microleakage between RMGIC and GIOMER. This may be because of both of RMGIC and GIOMER bond to tooth structure by nearly the same bonding mechanisms (chemical and mechanical bonding)[22]. However, the higher scores value of GIOMER when compared with RMGIC may be because of reduced marginal adaptation of GIOMER as well as the hygroscopic expansion which is an intrinsic property of this restorative material is the main cause of marginal deterioration of GIOMER restorations[19,22].

According to the results of the present study QTH, LED, and argon laser have insignificant influence on the microleakage of the RMGIC and GIOMER. This may be due to the presence of the same photoinitiator (camphorquinone) in the both material with maximum absorption spectrum at 468 nm, and all the LCUs used in the present study work within this spectrum where QTH between 390-580 nm, LED between 450-490 nm, and argon laser between 488-514 nm [23,24]. However, the lower scores value of microleakage of argon laser when compared to QTH and LED LCUs in the present study may be due to the higher intensity of argon laser light resulted in the higher degree of conversion but it able to reduce the polymerization shrinkage stresses of resin-based material and hence the marginal leakage compared with QTH and LED[24].

Moreover, the higher scores value of microleakage of GIOMER when compared with RMGIC regarding to light curing unit may be because of the smaller size of filler particles of GIOMER (0.8 µm) which tend to scatter the light. It was found that smaller filler particles (0.1 µm to 1.0 µm) have maximal scattering because these particle sizes correspond to the wavelength range of the photoinitiator [23].

CONCLUSIONS

All light curing units used in this study have no effect on microleakage of RMGIC and Giomer. The least microleakage occurred around the RMGIC group and the maximum microleakage was seen in GIOMER group. Also, the results revealed that Argon laser has lower scores value of microleakage when compared to QTH and LED LCUs.

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