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EFFECT OF PHOTO-POLYMERIZED VERSUS CHEMICAL CURED GLASS IONOMER BASED DESENSITIZING AGENTS ON PATENCY OF DENTINAL TUBULES

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ABSTRACT

Background: The diagnosis of dentin hypersensitivity is done by exclusion. Yet no universally accepted gold-standard treatment, which reliably relieves the pain of dental hypersensitivity in the long term and satisfy both the dentist and the patient, was found.

Objective: to compare the effect of photo polymerized versus chemical cured glass ionomer based desensitizing agents in respect to: a) Their ability to occlude the dentinal tubules. b)Their depth of penetration inside the dentinal tubules. **Materials and Methods:** A total of 20 permenant molars were selected, promximal enamel was removed, EDTA gel (17%) was applied for three min. The prepared fourty surfaces were divided into two groups. Half of both surfaces received different desensitizing agent while the other half was left untreated as a control. Each group was divided into four subgroups, the first subgroup faced abrasion challenge, the second faced thermocycling, third faced both abrasion and thermocycling and the last was left as a control group. An ESEM at 2000 magnification was used to observe the patent dentinal tubules, and a digital Analysis program was used to evaluate the patency.

Results: showed that the percent of obliteration of dentinal tubules when the samples faced abrasion only was higher in CGI than RMGI, same result when the samples face termocycling only it was still higher in CGI than RMGI. Whereas there was no statistical significance when the samples received both abrasion and thermocycling.

Conclusion: 1- The abrasion resistance and the ability of CGI to withstand thermocycling makes it better in occluding dentinal tubules rather than RMGI. 2- Although the resinous component of RMGI allows better penetration inside the tubules, yet the lower abrasion resistance and poor resistance to thermocycling made the material inferior in maintaining an efficient dentinal tubules seal.

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INTRODUCTION

Dentin hypersensitivity (DH) is characterized by a short, sharp pain as arising from exposed dentin in response to stimuli. Although dentin does not feel pain or sensitivity the pain is due to response of the pulp nerves to stimuli at the site of the dentin surface.[1] A degree of dentin sensitivity is normal, but pain is not usually experienced in everyday activities like drinking a cold drink. The hydrodynamic theory holds that, when an appropriate stimulus is applied to dentin, a change in the movement of fluid within the dentinal tubules occurs, creating a pressure change in the dentin and triggering a response in the pulp nerves, ultimately causing pain for the patient.[2] The dentin pulp complex may react to the decreased insulation by laying down tertiary dentin, which is a physiologic repair mechanism that takes time, thus increasing thickness between pulp and exposed dentin and reducing hypersensitivity symptoms.[3] The examination includes a pain provocation test by blasting air from a dental instrument onto the sensitive area, or gentle scratching with a dental probe.

If a negative result for the pain provocation test occurs, no treatment for dentinal hypersensitivity is indicated and another diagnosis should be sought[4] The mechanism of action of its treatment is either by decreasing dentinal tubules diameter using resins, varnishes, tooth pastes [5] or desensitization of nerve fibers/blocking the neural transmission using potassium chloride, potassium citrate or potassium nitrate.[6] Other treatments include the using of bonding agents and laser applications.[7]

MATERIALS AND METHODS

I. Materials:

Two materials were used in this study, RMGI (Vanish) and CGI (Fuji)

II. Methods

A total of 20 permanent recently extracted molars (from patients range 20-40 years old) Teeth were placed in phosphate buffered saline plus 0.02% thymol to control bacterial growth until they are used.

The teeth were mounted on cylindrical acrylic blocks (2 cm diameter and 4 cm height). An isometric saw was then used to remove proximal enamel to expose underlying dentin so that the width of cervical enamel and dimensions could be measured accurately from the proximal side by using a digital caliber, in order to estimate the amount of enamel to be removed buccally and lingually from the specimens.

Enamel was then removed buccally and lingually following DEJ as seen from the proximally exposed surface and it was taken as a guide for cutting in all samples which ranges between 1.5-2 mm. Soflex discs were used to finish and smoothen the surface.

EDTA gel with concentration 17% was used, it was applied by a brush for three min. to the whole buccal and lingual surfaces of all specimens in order to remove smear layer, then it was washed away with water and the surface was dried with mini sponge.[8] The prepared 40 surfaces were divided into two groups, 20 each according to the type of desensitizing agent received, The mesial half of each surface received the desensitizing material while the other half was left untreated as a control group knowing that EDTA was applied to both halves the treated and untreated of each buccal and lingual surfaces. Each group was subdivided into four subgroups (N=5), the first subgroup faced an abrasion challenge by A custom made machine that was built to simulate brushing technique[9,10] **Fig. (1)**. While the second faced thermocycling for 2000 cycles with a dwell time five sec. and temperature 5 to 55 C. [11] , the third faced both abrasion challenge and thermocycling and the last was left as a control group. A total of other ten lower molars were used to obtain occlusal dentin discs, five discs were prepared for each desensitizing material, to detect the depth of penetration and mode of attachment at the interface between dentin and the material (of a standard thickness 1mm). Occlusal enamel was removed, then smoothened by soflex discs. EDTA was applied first followed by the two desensitizing materials on the occlusal dentin discs as previously mentioned. A cross section imaging took place as each dentin disc was then broken into two halves manually with bare hands to avoid the formation of any smear layer, then it was viewed under the environmental scanning electron microscope (ESEM). [12]

All samples were observed in an environmental electron microscope at a 2000 magnification to observe the patent surface area of dentinal tubules.

Results were collected, tabulated and statistically analyzed using software SPSS 20.

RESULTS

The surface area of patent dentinal tubules for each tested group was measured in micrometers using Semaphore 5.21 and the percent of obliteration was calculated, with respect to the control group of each sample **Table (1)**.

Results of ESEM of the tested samples used illustrated from (**Fig 2-6**) show the patency of

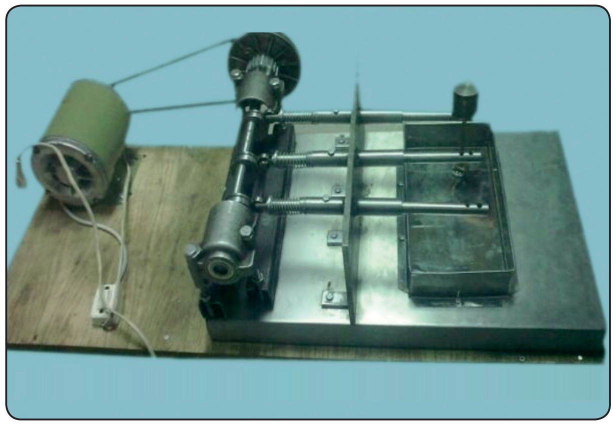

Fig.(1) Toothbrushing machine

dentinal tubules of dentin surface when facing both challenges abrasion and thermocycling after the application of both desensitizing agents CGI and RMGI .

ESEM image of cross sectioned dentin disc treated with RMGI (Vanish) **Fig. (7)** where the interface between dentin and the RMGI was noticed, a homogenous layer was seen with no gross filler particles, also there was a narrow hybrid layer just below the interface with very short resin tags formation inside the tubules after smear layer removal by EDTA. Where **Fig.(8)** showed the interface between CGI and dentin

TABLE (1): The mean, standard deviation (SD) values and results of Post hoc test for comparison between specimens without and with application of desensitizer with different interactions

		D_1(Vanish)				**D_2(Fuji)**			
		Patency tested portion	Controlled portion	Percent Of obliteration		Patency tested portion	Controlled portion	Percent of obliteration	
A_0	T_0	0.5	2.8	80.2[b]	0.45	0.8	2.5	83.4[a]	0.55
	T_1	0.64	2.6	75.1[d]	0.40	0.53	2.8	80.76[b]	0.55
A_1	T_0	0.92	3.1	70.3[e]	0.7	0.71	3.2	77.63[c]	0.25
	T_1	0.8	2.7	70.1[e]	0.60	0.97	3.1	68.53[e]	0.40

Different letters indicate significance.

I. Patency of the dentinal tubules

I. 1) Abrasion

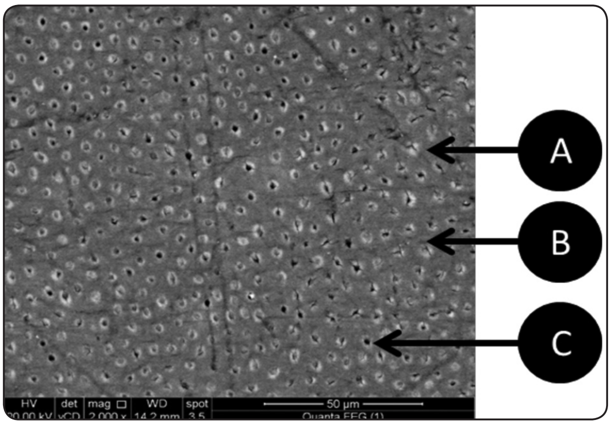

Fig.(2) ESEM image of dentin surface with abrasion left untreated as its control (only EDTA) where A: intertubular dentin B: peritubular dentin C: patent dentinal tubule

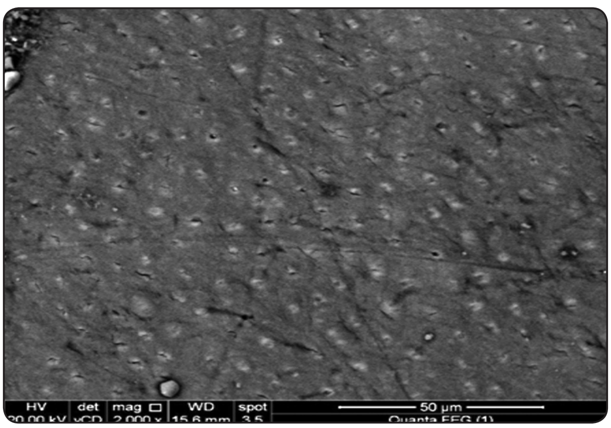

Fig.(3) ESEM of dentin surface treated with RMGI

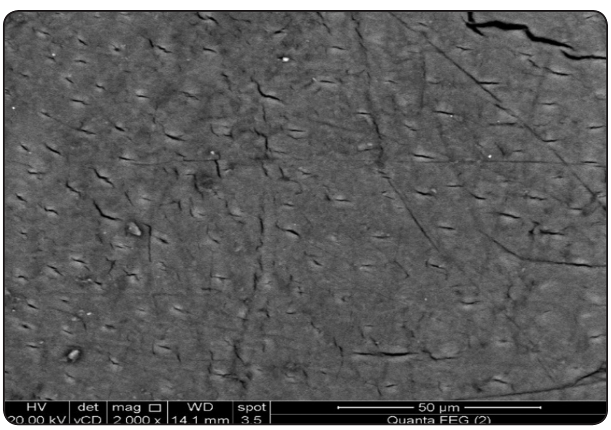

Fig.(4) ESEM of dentin treated with CGI

I.2) Thermocycling

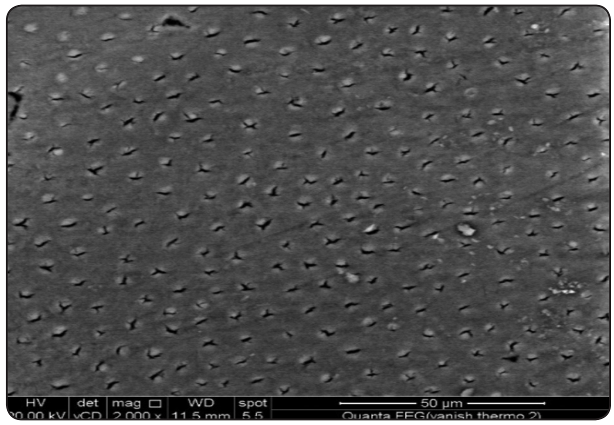

Fig.(5) ESEM image of dentin with RMGI

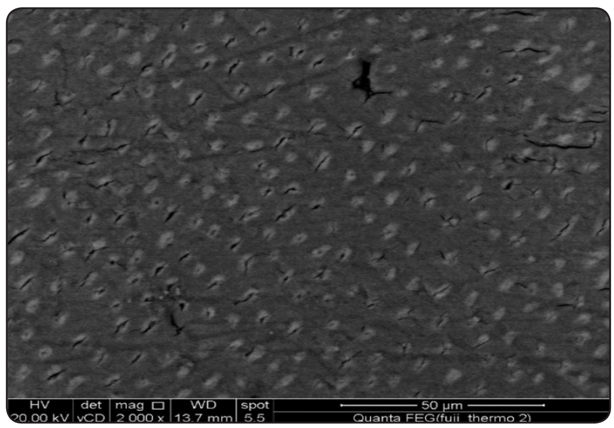

Fig.(6) ESEM image of dentin surface with CGI

DISCUSSION

RMGI was discussed by Wilson et al. (1990), Their chemistry and properties are examined and compared with CGI. [12] The two desensitizing agents were evaluated together with the techniques used to address their effects on the prepared dentin surface and the ability of these agents to decrease permeability through tubule occlusion. It can be concluded that the use of this model to determine

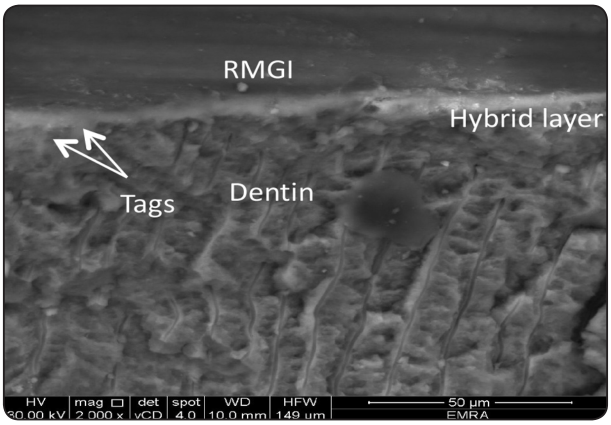

Fig. (7) ESEM image showing the interface between dentin and the RMGI

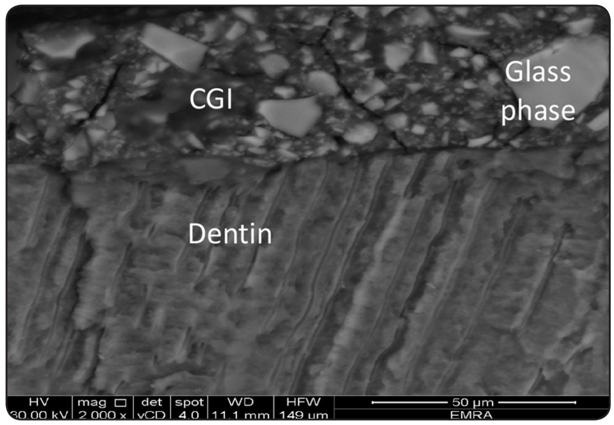

Fig. (8) ESEM image showing the interface formed between CGI and dentin

surface characteristics and reductions in dentin permeability through tubule narrowing or occlusion, provides a useful screening method for evaluating potential desensitizing agents.[13]

EDTA was chosen because the tested material was glass ionomer, so potent acids such as phosphoric or hydrochloric acids that could be used in acid etching for composite resins are not indicated for bonding of glass ionomer since they have acidic pH that do demineralization and not chelation, also it has been reported that pre-surface treatment of dentin with different agents rather than EDTA may cause alterations in the chemical and structural nature of dentin, which as a result may change its permeability and solubility characteristics.[14] EDTA effeciency is related to its ability to withdrawl the inorganic portion of the smear layer by reacting with the calcium ions in dentin to form soluble calcium chelates.[15] The time of application of EDTA ranges from 30 sec. to 10 min. Using EDTA for 30 sec. has shown efficient smear layer removal.[16]

It was observed that the most amount of calcium ions were removed during the first three min. when using EDTA.[17] Although the action of gel and solution forms of EDTA is the same, the benefit of lubricant in gel form is that it allows better mastering of the operator on its application. [18] It was found in some studies that thermocycling increase leakage, and that 10,000 cycles is equivalent to one year of clinical life.[19] .

It was observed that thermocycling generate thermal expansion and contraction stresses with an increase in chemical degredation, also the same study listed that RMGI undergo hygroscopic expansion when stored for one week in water which reduce gap formation.[20] Regarding the effect of abrasion on the percent of obliteration of dentinal tubules by the materials, it was shown that CGI (Fuji Triage) is more resistant to abrasion than RMGI (Vanish), which agrees with Momoi et al. (1997)[21] , this could be attributed to the defeciency in maturation of superficial layer of the RMGI as a result of the air inhibition due to the presence of an oxygen inhibited layer.[22]

It was found that the percent of obliteration of dentinal tubules was higher in CGI (Fuji) than RMGI (Vanish) which is similar to what was found by Tantbirojn et al. (2006)[23]. Nicklson et al. (2008) explained that the presence of HEMA alters acid base reaction in RMGI so that it becomes slower and significantly weaker material with compressive strength equals or less than that of the CGI[24] . On the other hand, there were some studies that disagreed.

Results concluded that CGI (Fuji) occluded the tubules more effectively than RMGI (Vanish) which opposes Mielczarek et al. (2013) who compared the effect of a RMGI varnish with a sodium fluoride containing varnish on dentin tubules occlusion and demonstrated that RMGI varnish was more effective in dentin tubules occlusion than the other varnish(25), the outcome contradicted Daniela et al. (2002) who concluded that the flowable consistency glass ionomers (diluted Vitremer and Fuji Plus) were less resistant to tooth brushing abrasion and had the greatest increase in superficial roughness when compared to resin based sealant and restorative ionomers (26), also difference in the materials and consistency of the CGI used.

It was believed that the greater the size and ratio of filler particles the greater the abrasion resistance and less solubility, where smaller filler particles sizes increase the susceptibility to erosion, causing displacement of inorganic particles & greater exposure of air bubbles incorporation during mixing. (27) Sampaio et al. (2011) found that Specimens with CGI liners had gap size higher than groups with RMGI when subjected to thermocycling. this opposes our result in the current study where CGI (Fuji Triage) had higher obliteration percent than RMGI (Vanish) after thermocycling. (11)

The result when thermocycling only was done, showed that the percent of obliteration was higher in CGI than RMGI which means CGI was more resistant to thermocycling than vanish. Arici et al. (2003) disagreed with this result as the effects of thermocycling on the shear bond strength of RMGI and CGI was discussed. The results suggest strongly that RMGI provide a viable alternative to composite resins, with satisfactory in vitro shear bond strength even after 20,000 cycles.(19) Abdulla (2000) evaluated the micromorphological interface between hybrid ionomers and dentin. He found that RMGI produced a narrow hybrid layer as well as formation of very short resin tags inside the tubules, he refered to the amount of resinous content (HEMA) and its effect on the depth of penetration inside the tubules (28) which is in agreement with this study. Also the mode of surface conditioning with organic or inorganic acid to remove smear layer was discussed (29). Although in our study it was found that RMGI even though the formation of a hybrid layer and the shallow penetration of resin tags inside the tubules were obvious, yet its inferior surface properties (hardness 12.4 Hv) and the value of coefficient of thermal expansion failed to withstand the challenges received (abrasion and thermocycling), while CGI performed better against thermocycling and abrasion which could be due to its higher surface properties (hardness 18.2 Hv). This agrees with Madruga et al. (2017)(13). Unlike Freitas et al. (2011)(30) and Daniela et al. (2002)(26) who disagreed as the physical properties of RMGI and CGI were compared and showed that RMGI has superior physical properties than CGI.

CONCLUSION

1- The abrasion resistance and the ability of CGI to withstand thermocycling makes it better in occluding dentinal tubules rather than RMGI.

2- Although the resinous component of RMGI allows better penetration inside the tubules, yet the lower abrasion resistance and poor resistance to thermocycling made the material inferior in maintaining an efficient dentinal tubules seal.

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