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Microleakage Evaluation of Class V Resin Composite Restorations with Fluoride Iontophoresis Application on Tooth surface (an in vitro study)

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ABSTRACT

Purpose: This study was directed to evaluate the microleakage of class V composite restoration after fluoride Iontophoresis application on tooth surface. **Materials and Methods** :60 freshly extracted human non carious premolar teeth were used box-shaped Class V cavities (4x2x2 mm) were prepared on the gingival one third of the tooth with occlusal margin in enamel and gingival margin in cementum half of the teeth received fluoride Iontophoresis application (FI), while the other half were not received any treatment (NF). Teeth were restored with Z250 resin composite and Kalore resin composite. The specimens stored for one month, three months and six months in distilled water at 37^o C in an incubator. After storage time, specimens were immersed in dye of silver nitrate for 12 hrs. The tooth restoration interface was investigated under Scanning Electron Microscope (SEM). **Results:** no significant difference in microleakage of both restorations. Lower leakage score for the fluoridated group than none fluoridated one. Microleakage levels were higher in teeth occlusally than cervically. **Conclusion:** Microleakage is adversely affected by Fluoride iontophoresis.

KEYWORDS

Fluoride iontophoresis, Class V, Microleakage, Composite.

INTRODUCTION

Microleakage of resin composite restorations is most frequently associated with debonding of resin restoration interface. Sealing of the exposed dentin from the oral environment, to prevent decay and further pulpal damage [(1)]. Polymerization shrinkage generates stresses within the resin composite and at the margins. Leakage may occur at the tooth restoration interface if the stresses are higher than the bond strength [(2)]. Kalore is a low shrinkage resin composite and has a unique property of DX511 monomer which consists of a long rigid core with flexible side

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arms and a lower number of double bonds make it less shrinkable composite [3].

Fluoride ion as anti-caries agents may use in different purpose [4]. Iontophoresis of 2% NaF and Acidulated Phosphate Fluoride gel (APF) effective in tooth sensitivity reduction than topical fluoride applications [5]. Fluoride iontophoresis may increase the concentration of fluoride ions in dentinal tubules[6]. Fluoride application before resin composite restorations have a different may have effect on bond strength [7]. Pretreatment of fluoride Iontophoresis before bonding of composite resin restorations may affect the microleakage.

MATERIALS AND METHODS

Table (1): *resin composite and their adhesive*

P roduct name	Category	Composition	Manufacturer and Batch number
Feltik Z250xt (A3)	Nano Hybrid Composite	Zirconia filler loading is 60%by vol, particle size range of 0.01-3.5microns and nanofillers. Bis-GMA** and TEGDMA(+) resin.	3M, St. paul, MN, USA www.3m.com.
Universal Adhesive 3M	One step Self-Etch Adhesive	MDP phosphate monomer, (HEMA)(*), Methacrylated phosphoric esters, nanosilica filler with 7 nm, Ethanol, Water, Initiators based on camphorquinon.	3M, Seefeld, Germany. www.3m.com
Kalore ShadeA3	nano-hybrid composite	Urethane dimethacrylate(UDMA)++ 18%, DX-511 co-monomer,Dimethacrylate,Fillers(Fluoroaluminosilicate glass), Prepolymerized filler, Silicon dioxide, photo initiator, Pigment	GC, Tokyo Japan (1010091) Website www.gc-dental.com
G-aenial (One step)	Selfetch adhesive	4-Methacryloxyethyltrimllitate anhydride 5-10%, acetone 30-40%, water 15-20% , Dimethacrylat 15-20%, phosphoric acid ester monomer 15-20%, silicon dioxide 1-5% , photoinitiator	GC, Tokyo Japan (12101121) Website: www.gc-dental.com

*BIS-GMA:bisphenol-diglycidyl-ether-dimethacrylate, +TEGDMA:tri-ethylene-glycol-dimethacrylate, *HEMA: 2-hydroxyethyl-methacrylate ++UDMA: Urethane dimethacrylate.

Fluoride iontophoresis device (Jonofluor, Medical, Via Olivera, Italy) **and its Fluoride gel (Fig. 1):**

This device consists of a plastic tray with metal plate in the fitting surface of the try extended above the handle and a disposable grooved sponge adapted in the try that act as a carrier for the fluoride gel. Two electrodes; the positive anode and the negative cathode. A gel of1.23% acidulated phosphate fluoride (APF) was used with a specification of (12 300 ppm Fluoride at pH 3.5). Milliampere (mA) monitor display range from (0.2 mA,0.4 mA). Battery charge for current supply and switch on / off.

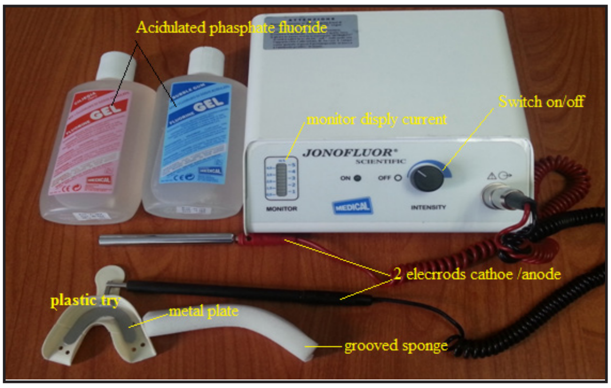

Figure (1): Iontophoresis device.

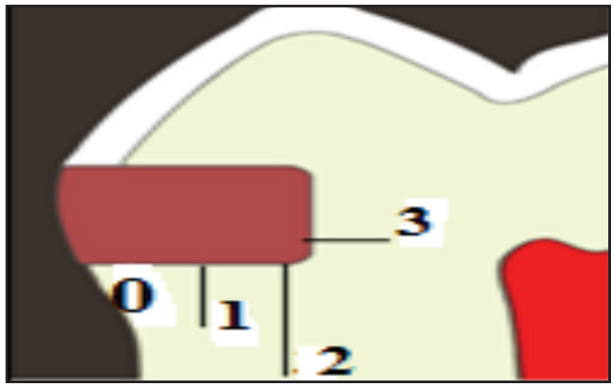

Figure (2): Diagram represinting the score of microleakage.

Sixty freshly extracted human premolar teeth intact without any cracks or fractures and any developmental anomalies were used. Box-shaped Class-V cavities (4 mm mesio-distally, 2 mm and 2 mm occluso-gingivally) were prepared on the cervical one third of the tooth with enamel margin occlusally and cementum margin gingivally. Teeth were divided into 2 halves: half of the teeth received fluoride Iontophoresis application (FI), while the other half were not received any treatment (NF).

Iontophoresis was done for 30 prepared teeth with 1.23% APF gel according to manufacturer's instructions, and electrically charged for 4 min with 0.4 mA, 12 V, then washed grossly with copious water, while the other 30 prepared teeth were not receiving any fluoride treatment (NF). After that, Z250xt resin composite (Z) and Kalore resin composite (K)were used (according to the manufacturer's instructions) with incremental placement technique and curing for 40 sec. After restorative procedures the teeth were stored for 1 month (T1),3 months (T3) and 6 months (T6) in water at 37°C in an incubator with 100% humidity until they were tested. Silver nitrate dye aqueous solution with (pH 9.5) were used specimens' immersion for 24 h, then 8h in a solution of photo-developing.

The degree of dye penetration was assessed by using a modified scoring system according to the following criteria (Fig.2):

Score 0: No dye penetration

Score I:1mmpenetrationof dye in the wall.

Score II: 2mmpenetration of dye and extend along the cervical floor and in the occlusal wall.

Score III: Dye penetration extend more than the entire length of the wall and extend one-half of the axial wall of class V.

Statistical analysis for the mean of each group were done by Kruskal–Wallis test, then, Mann–Whitney U test to evaluate different variables. The level of significance was at ($P \leq 0.05$). Software IBM® SPSS® Statistics version 20 was used.

RESULTS

Occlusal Margin:

F (Fluoride Iontophoresis) groups: a statistically significant difference for of Z group between occlusal at T3 and at T6, While, no statistically significant difference in K group betweenT3/Occlusal and T6/ occlusal.

NF (No Fluoride) groups: a statistically significant difference between T3 and T6/occlusal. While no statistically significant difference between Z group at T3/occlusal and T6/occlusal.

Gingival Margin:

F (Fluoride Iontophoresis) groups: a statistically significant difference between Z group at T1/gingival and T3/gingival. While no statistically significant difference betweenT3/gingival and T6/gingival.

NF (No Fluoride) groups: a statistically significant difference between K group at T1/gingival and each/T3/gingival or T6/gingival.

Table (2): *The mean and standard deviation (SD) values for dye penetration in (Class V) groups Occlusal and Gingival margins.*

Group / Time	(Class V)								*P*-value
	Occlusal Margin				Gingival Margin				
	F		NF		F		NF		
	Z Mean ±SD	K Mean ±SD	Z Mean ±SD	K Mean ±SD	Z Mean ±SD	K Mean ±SD	Z Mean±SD	K Mean ±SD	
T1 (1month)	0.10±0.03	0.20±0.04	0.80±0.07	0.8±0.07	1.00±0.8	0.70±0.08	1.00±0.6	0.90±0.3	<0.05*
T3 (3months)	0.50±0.05	1.40±0.08	2.10±0.8	2.30±0.6	2.00±0.9	1.50±0.8	2.00±0.8	1.50±0.5	<0.05*
T6 (6months)	1.70±0.1	1.50±0.5	2.30±0.6	2.70±0.6	2.40±0.6	2.70±0.4	2.40±0.8	2.10±0.9	<0.05*

**; significant (p<0.05)   ns; non-significant (p>0.05)*

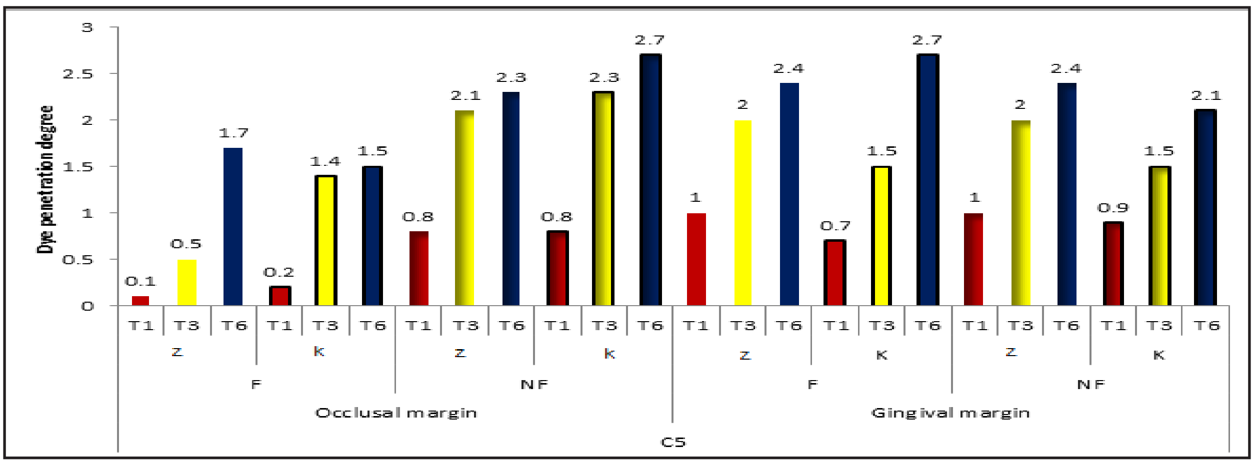

Figure (3): Bar chart representing dye penetration in Class V groups Occlusal and Gingival margins.

Scanning Electron Microscope observations:

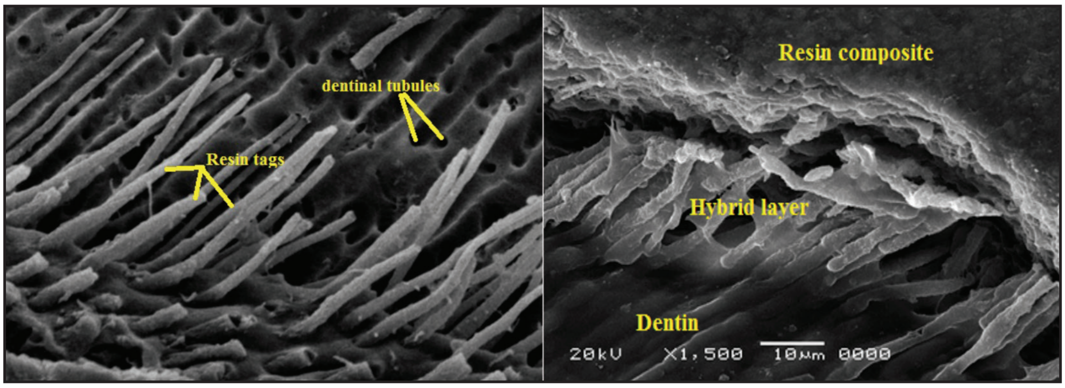

Figure (4): Scanning electron micrograph (SEM) of fluoridated group at the resin dentin interface (at 1500X) showing; (the right) gap at the interface of Z group at 6 months while (the left) showing resin tags that not attached to the dentinal tubules

DISCUSSION

In the current study, Fluoride Iontophoresis FI (generate a current to activate the ions of fluoride) was applied to the prepared specimens. The fluoride ions reacted with calcium ions forming acid-resistant calcium fluoride [8]. Fluoride particle ions (size, form and depth) is directly proportion to the frequency and duration of FI treatment to dentin [9]. This may change the infiltration of adhesive system in dentinal tubules to more extent with reduction of depth resin tags [10].

Fluoridated groups revealed lower leakage score than non-fluoridated one at three and six storage times. While at one-month storage, fluoridated specimens had higher leakage score than non-fluoridated groups.

This may be attributed to that fluoride ions chemically form fluorapatite that occluded partially or completely dentinal tubules from the reaction of fluoride and calcium of hydroxyapatite. Precipitation of fluoride ions after FI may decrease the dentinal tubule diameter that decrease fluid conductance in the tubules [11]. The bond strength may be affected by fluoride reaction products at the tooth surface [12].

Self-etching bonding systems do not require a separate acid etched, dissolve smear layer but does not remove it. The dissolved calcium phosphates with low hydrolytic stability and chemically interaction with the superficial resin-infiltrated zone [13,14]. The advantage of leaving hydroxyapatite-crystals in self-etching system within the collagen fibrils may chemically reacted with fluoride ions which may establish chemical bond and get a high bond strength[15-17].

On the other hand the higher leakage score of fluoridated groups after one month storage, may attributed to FI that may decrease deeper infiltration of resin monomers and affected the adhesive power into the penetration of fluoridated specimens, the same as for the application of potassium oxalate that may occlude the dentinal tubules [18].

The results of fluoride application were in agreement with the results that revealed low microleakage in the group that received acidulated phosphate fluoride (APF) before composite resin placement than the control group [9]. Another study showed that pre-treatment with fluoride could not affect the marginal leakage [19]. Also, a previous study showed the treatment with APF before bonding results in on significant change in composite bond retention [20].

Furthermore, the result of this study counteracts the study that found more microleakage of dental fluorosed teeth that have a weak bonding of resin dentin interface and this may be due to fluorapatite which had hyper mineralized surface [10]. microleakage is directly proportion to dental fluorosis. The higher the fluorosis with subsurface enamel porosity the higher microleakage [21].

Moreover, this result in agreement with the result which stated that FI resulted in partially obliteration of exposed dentinal tubules and did not reduced significantly the bond strength of self-adhesive system[7]. Also, treatment with APF before bonding process related to fissure sealant treatment did not reduce the bond strength [22].

This result was disagreed with the result that revealed pre-treatment of fluoride therapy is a reason for decrease in bond strength of restorations that lead to marginal gap formation [23]. Also, fluoridated appetites crystals are cited as a factor that make less number of chemical bonds than hydroxyapatites that cause debonding of restoration and leakage [24].

CONCLUSION

1. Microleakage is adversely affected by fluoride iontophoresis.
2. Fluoride iontophoresis treatment preserve bond strength.
3. Water storage for long time increase microleakage.

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