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Clinical Evaluation of Two Glass Ionomer Restorative Materials in Class I Cavities

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Abstract
Aim*: To evaluate the clinical performance of two Glass ionomer restorative materials (EQUIA Forte Fil) and (IonoStar Molar) and a nano hybrid composite (Tetric EvoCeram) in Class I cavities over one year.*
Materials and Methods*: Twenty patients of age 25-40 years received sixty restorations. Each patient received 3 different restorations representing the tested materials. Class I cavity was prepared according to the caries extension. All the materials were applied following the manufacturer's instructions. Finishing and polishing was performed using finishing burs and polishing discs. Each restoration was evaluated clinically at baseline (24 hours), 6 months and after one year using modified USPHS.*
Results*: The recall rate was (100%) after 1 year. The alpha rating for retention and restoration fracture for EQUIA Forte Fil were (95%), IonoStar Molar (85%), Tetric EvoCeram (100%) alpha ratings. For marginal discoloration for EQUIA Forte Fil (95%), IonoStar Molar (80%), Tetric EvoCeram (95%) alpha ratings. For marginal adaptation for EQUIA Forte Fil (90%), IonoStar Molar (80%), Tetric EvoCeram (90%) alpha ratings. For anatomic form for EQUIA Forte Fil (95%), IonoStar Molar (75%), Tetric EvoCeram (95%) alpha ratings. For color match for EQUIA Forte Fil (85%), IonoStar Molar (80%), Tetric EvoCeram (90%) alpha ratings. For surface texture for EQUIA Forte Fil (85%), IonoStar Molar (90%), Tetric EvoCeram (95%) alpha ratings. For secondary caries for EQUIA Forte Fil (95%), IonoStar Molar (85%), Tetric EvoCeram (100%) alpha ratings.*
Using Chi-square test, there was no statistically significant difference between the tested groups for marginal discoloration, marginal adaptation, anatomic form, color match, and surface texture ($p>0.05$)
CONCLUSION*: EQUIA Forte Fil Glass ionomer achieved clinically superior results after one year of service. IonoStar Molar Glass ionomer also achieved acceptable results. Tetric EvoCeram composite achieved superior clinical results for all criteria of the evaluation. A longer evaluation period may be recommended to decide the use of these materials safely in Class I cavities.*
Keywords: *Glass ionomer; Clinical; Class I Cavity.*

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I. Introduction

Composite resin is a good material for restoring Class I cavities, some advantages can be related to composite restorations such as better esthetics, adhesive properties, conservative cavity preparation, and reinforcement of the remaining tooth structure [1] . Clinical longevity and durability of composite restorations in stress-bearing areas of posterior teeth depend on when these materials sustain polymerization stress. However, polymerization shrinkage is the main problem that leads to the volumetric reduction within the material at the restoration-tooth interference [2]. Postoperative sensitivity, micro-leakage, marginal staining, and gap formation are problems that lead to limitations in the application of direct restorations [3].

Although composites show a similar success rate to amalgam restorations in the short term, in the long term their success rate seems to decline. Marginal discoloration, loss of retention, and secondary caries are considered as the main causes of failure in composite resin restorations, with these being attributed mainly to polymerization shrinkage [4]. Composite resin is a technique-sensitive material requiring a precise placement protocol and its success may be compromised when tooth isolation or patient cooperation cannot be successfully achieved [5].

Recently the development of nano filled composites which have nano-sized filler particles for increasing weight percentage of composites. Nano filled composites have advantages like decreased

polymerization shrinkage, increased fracture and wear resistance of the material, and high polish in stress-bearing areas [6] ,furthermore, have availability of a wide range of colors and ability to mimic the tooth structure, less shrinkage during curing, low water absorption, perfect properties of polishing and texturing, abrasion and wear nearly identical to that of tooth structures, similar coefficient of thermal expansion to that of dental structures, universal formulas for anterior and posterior areas, also have various degrees of opaqueness and translucency in different tones and fluorescence [7].

Glass Ionomer Cement was first introduced by Wilson and Kent [8]. It is water-based cement, known as polyalkenoate cement. Over the years many modifications have been performed on this material. The physical properties especially wear resistance, reduced sensitivity to water uptake in the early stage of setting so that restorations could be placed and finished at the same visit andtranslucency was improved by reducing filler size and increasing their viscosity to achieve packability and so they could be used in a wide range of clinical applications [8] .

Compared to other permanent filling materials like resin-based composites, glass ionomer cements have several advantages like the ability to adhere to moist enamel and dentin and anti-cariogenic effect such due to the long-term fluoride release [9]. Other clinical advantages such as biocompatibility and low coefficient of thermal expansion support their usage in the daily dental practice [10]. Despite having these significant advantages, they have poor surface polish, high porosity, and poor mechanical properties as brittleness, surface wear, and fracture toughness [11] . So, it was questionable that glass ionomer cement represent an alternative material for amalgam or resin-based composites in posteriorteeth [9], [12].

A new material called EQUIA was introduced in order to combine the main advantages of the highly viscous glass ionomer cement with a nano-filled light-curing varnish. This varnish provides surface protection in the early setting phase and occluding any surface cracks and porosity and will increase the wear resistance and toughness of the material and this is needed in the first months until the GIC is totally matured and can afford the intraoral stresses [13], [14] .

II. Materials and Methods

(1) Materials:

Table (1): The materials that were used in the study:

Material	Chemical composition	Manufacturer	Web Sites
EQUIA Forte Fil Glass ionomer	Powder: 95% strontium fluoro-alumino-silicate glass, 5% polyacrylic acid liquid:40% aqueous polyacrylic acid	GC Co, Tokyo, Japan	www.gc-dental.com
GC Cavity conditioner	20% polyacrylic acid and 3% aluminum chloride hexahydrate.	GC Co, Tokyo, Japan	www.gc-dental.com
EQUIA Coat	Methylmethacrylate, colloidal silica, camphoroquinone, urethane, methacrylate, phosphoric ester, monomer	GC Co, Tokyo, Japan	www.gc-dental.com
IonoStar Molar Glass ionomer	Calcium fluoro -aluminosilicate glass Poly acrylic acid , tartaric acid	VOCO GmbH, Cuxhaven, Germany	www.VOCO.com
Final Varnish	BIS GMA, 1,6 hexanediylbismethacrylate	VOCO GmbH, Cuxhaven, Germany	www.VOCO.com
Tetric N Bond Universal adhesive	Bis-GMA, urethane dimethacrylate, dimethacrylate, hydroxyethyl methacrylate, phosphonic acid acrylate 80.	Vivadent, Schaan, Liechtensten	www.IvoclarVivadent.com
Tetric EvoCeram Nano filled composite	BIS-GMA, Urethane Di methacrylate, Barium glass filler, Pigments	Vivadent, Schaan, Liechtensten	www.IvoclarVivadent.com

The materials used in this study were 2 Glass ionomer materials (EQUIA Forte Fil (glass ionomer with glass hybrid technology)and IonoStar Molar) and a nano-hybrid composite material (Tetric EvoCeram) used in combination with Tetric N-Bond Universal adhesive.
The chemical composition, manufacturer and web sites of each material represented in Table1.

Patient selection:

Twenty patients were selected according to inclusion and exclusion criteria. Inclusion criteria were patients of an age ranging between (25-40) years, good oral hygiene, absence of tooth mobility, good general health, having normal occlusion, presence of three carious occlusal lesions, patients with no smoking habits and easily contacted and available for follow-up recalls up to one year.Exclusion criteria werepatients with poor oral hygiene, patients with high caries index, high plaque index or with improper oral health care, abnormal occlusion or with no occlusal contact, any parafunctional habit such as tooth clenching or grinding, history of allergy towards resin material and orthodontic treatment.The purpose of the present study was explained to the patients and informed consents were obtained according to the guidelines on human research published by the Research Ethics Committee at Faculty of Dentistry, Tanta University.
Patients were given oral hygiene instructions before operative treatment, and when needed they were referred to the periodontology department for scaling and polishing.
Restorative procedures:
Each patient should have at least 3 Class I carious lesions. After obtaining ethical clearance. A total of 60 cavities were made and randomly distributed into 3 groups and restored with tested materials as follow:

- Group 1: EQUIA Forte Fil Glass Ionomer (18 molars and 2 premolars).
- Group 2: IonoStar Molar Glass Ionomer (18 molars and 2 premolars).
- Group 3:Tetric EvoCeram composite with Tetric N-Bond Universal. (19 molars and one premolar).

(a) Cavity preparation:

Local anesthetic solution was administrated to the patients preoperatively and the operating field was isolated using rubber dam to prevent salivary contamination and to facilitate the restorative procedures.

Class I cavity was prepared according to caries extension. Cavity preparation was limited to just removal of carious lesions without any special retention aids (no undercuts) and no bevels. All the cavities were prepared using plain carbide fissure bur held in high speed contra angled hand piece with water cooling system. All internal line angles were slightly rounded. Each bur were replaced after 5 preparations. Deep caries - if present - was removed with large rose head bur at low speed with water cooling system and a thin layer of calcium hydroxide was placed.(Urbical chemical cure – PROMEDICA Company –Germany)
Placement of restorative materials
All materials were applied according to manufacturer instructions as follow:
EQUIA Forte FilGlass Ionomer

GC cavity conditioner was applied for 10 seconds to the cavity using a cotton pellet or sponge, then the cavity was rinsed with water spray and dried with air (not over dry). The capsule of EQUIA Forte FilGlass ionomerwas activated by pushing the plunger until it was flush with the main body and mixed using an amalgamator for 10 seconds.The mixture was inserted into the cavity using an application device within 10 seconds after mixing. The preliminary contour during the working time which was 1 minute 15 seconds from the start of mixing. After setting time which was 2 minutes 30 seconds from the start of mixing, finishing was done under water spray using superfine diamond burs and the occlusion was checked to prevent premature contacts. Silicone polishers and polishing discs were used to polish the restorations. A layer of G-Coat (GC) was applied and cured using light curing device for 20 seconds.

IonoStar Molar Glass Ionomer

The cavity was cleaned, rinsed with water spray and dried with air (not over dry). The capsule was activated by pressing down the end of the capsule onto a hard surface and mixed using an amalgamator for 10 seconds. The mixture was inserted into the cavity using an application device within 15 seconds of the end of mixing then a layer of Final Varnish was applied with a disposable brush on the cement surface after 1.5 minutes of working time and cured using the light-curing device for 10 seconds.

The restoration was finished after setting time (6 minutes from start mixing) using diamond burs and the occlusion was checked to prevent premature contacts.Silicone polishers and polishing discs were used to polish the restorations. Another layer of Final Varnish was applied and cured for 10 seconds.

Tetric EvoCeram composite with Tetric N bond Universal

The cavity was cleaned, rinsed with water spray and dried with air (not over dry). Tetric N-Bond Universal adhesive was applied to the tooth surfaces using a disposable applicator brush and scrubbed into the tooth surface for at least 20 seconds, then dispersed with oil- and moisture-free compressed air and cured using a light-curing device for 10 seconds using a light intensity of ≥ 500 mW/cm2.Tetric EvoCeram composite was

applied in layers of max. 2 mm and cured for 20 seconds for each layer with a light intensity of ≥ 500 mW/cm2. The light curing device used was CromaluxE, MEGA-PHYSIK, GmbH &COKG, Germany).
Excess material was removed with diamond or tungsten carbide finishers after polymerization. The occlusion was checked to prevent premature contacts or undesired articulationpaths on the surface of the restorations. Silicone polishers and polishing discs were used to polish the restorations.

Clinical evaluation procedures:

Each restoration was evaluated clinically at baseline (24 hours), 6 months and after one year using modified USPHS (Table 2). These criteria include retention rate, color matching, secondary caries, anatomic form, surface texture, marginal discoloration, restoration fracture, and marginal adaptation. The patients were asked whether any sensitivity, pain or discomfort (yes/no) occurred before and after the treatment.

Also, intraoral color digital photographs were taken at each evaluation visit as a permanent record for subsequent indirect evaluation and later reference. Two calibrated investigators evaluated the restorations. If disagreement occurred between the examiners, a third equally calibrated expert was asked for the evaluation. Restorations were scored as follows: Alpha represented the ideal clinical situation; Bravo is clinically acceptable; Charlie is clinically unacceptable situations where the restoration has to be replaced.

Statistical Analysis

The data of the retention rate, color matching, secondary caries, anatomic form, surface texture, marginal discoloration, restoration fracture and marginal adaptation along all the evaluation periods were collected, tabulated and statistically analyzed using software Statistical Package for Social Sciences (SPSS) computer program.

Samples of photographs for some restorations at different recall periods (baseline, 6 months and one year) were shown in figures (1), (2) and (3).

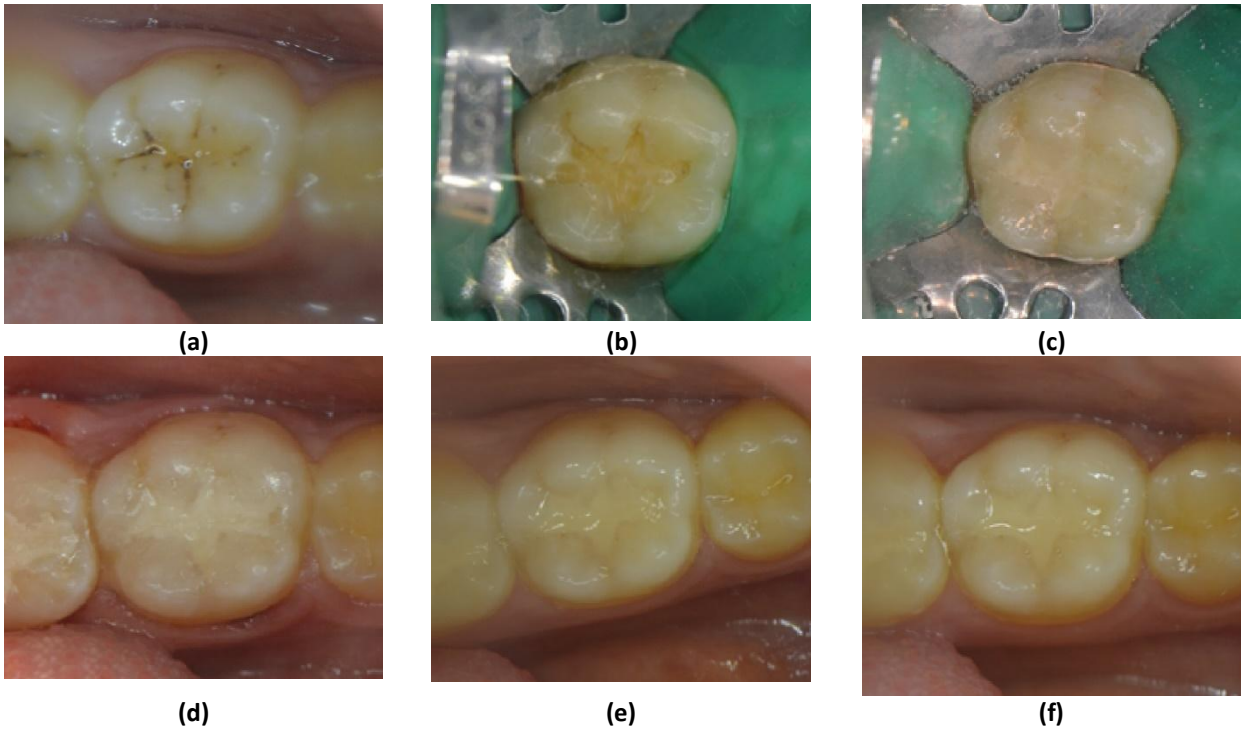

Fig (1): IonoStar Molar GI restoration at different evaluation periods.
A: Carious occlusal lesion at lower right first molar. B: Cavity preparation; C: restoration immediately after finishing; D: restoration at baseline (24Hours); E: restoration after 6 months; F: restoration after one year.

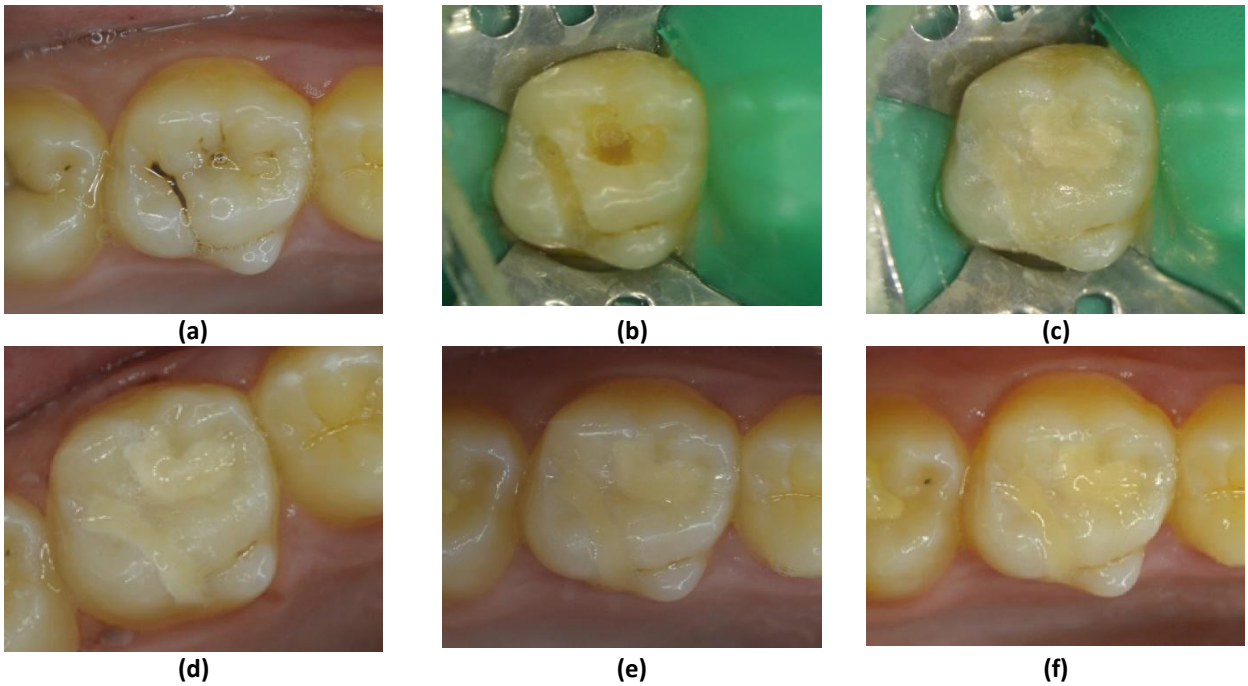

Fig (2):EQUIA Forte Fil GI restoration at different evaluation periods.
A: Carious occlusal lesion at upper left first molar; B: Cavity preparation; C: restoration immediately after finishing; D: restoration at baseline (24Hours); E: restoration after 6 months; F: restoration after one year.

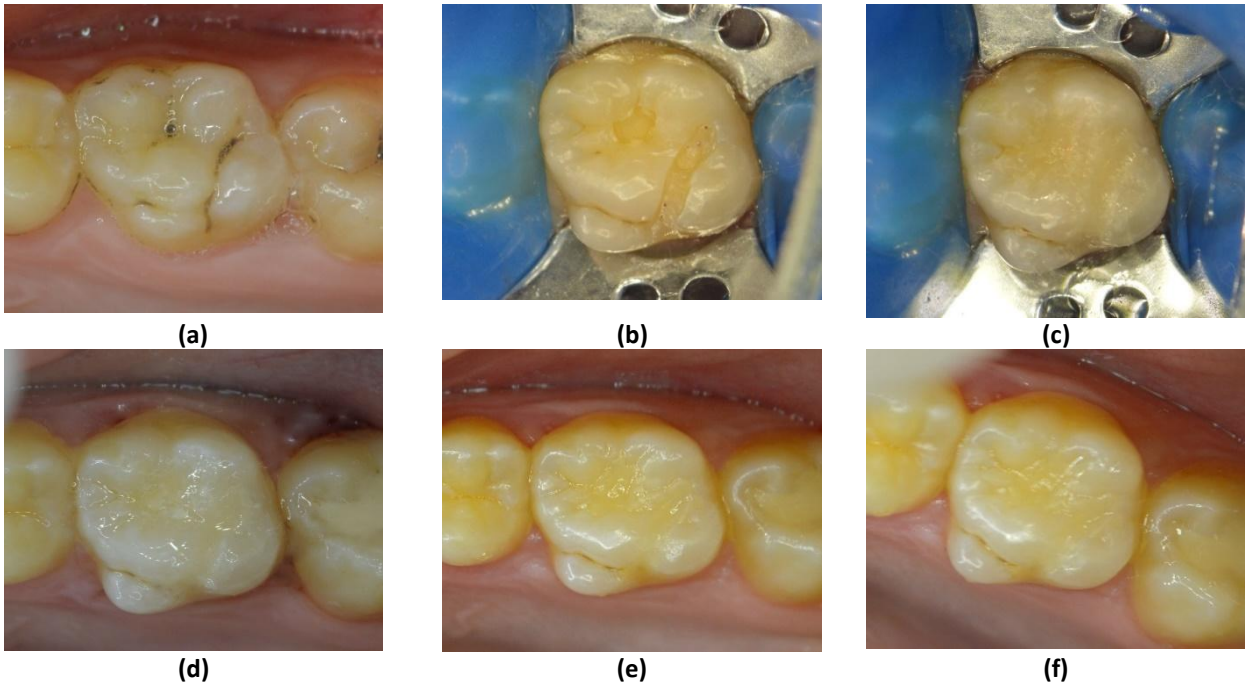

Fig (3): Tetric EvoCeram composite restoration at different evaluation periods.
A: Carious occlusal lesion at upper right first molar; B: Cavity preparation; C: composite restoration immediately after finishing; D: restoration at baseline (24Hours); E: restoration after 6 months; F: restoration after one year.

III. Results

The data were collected, tabulated and statistically analyzed using Statistical Package for Social Sciences SPSS version 20. In this study, 60 restorations were evaluated at baseline (24 hours), six months and one year. The recall rate was 100% at all evaluation periods and all criterion at baseline showed 100% alpha rating.

Retention rate: The data for retention were shown in Table (2). After one year, one EQUIA Forte Fil Glass ionomer restoration was lost with no significant difference according to Chi-square test. For IonoStar Molar Glass ionomer three restorations were lost which considered highly significant difference p-value (0.043). For Tetric EvoCeram composite, no restoration was lost.

Restoration fracture: The data for restoration fracture were shown in Table (3).

After one year, nineteen EQUIA Forte Fil restorations showed absence of fracture, one restoration showed prescence of fracture. For IonoStar Molar, seventeen restorations showed absence of fracture and three restorations showed prescence of fracture with a significant difference p-value (0.043). For Tetric EvoCeram composite all restorations showed absence of fracture.

Marginal discoloration: The data for marginal discoloration were shown in Table (4). After one year, nineteen EQUIA Forte Fil restorations showed no discoloration at the margins and one restoration showed shallow discoloration, for IonoStar Molar, sixteen restorations showed no discoloration at the margins, one restoration showed shallow discoloration and three restorations showed deep discoloration, for Tetric EvoCeram composite nineteen restorations showed no discoloration at the margins and one restoration showed shallow discoloration.

Marginal adaptation: The data for marginal adaptation were shown in Table (5). After one year, eighteen EQUIA Forte Fil restorations showed closely adapted margins and two restorations showed evidence of crevice along the margins with no exposed dentin. For IonoStar Molar, sixteen restorations showed closely adapted, two restorations showed prescence of crevice along the margins with no exposed dentin and two restorations showed crevice with exposed dentin. For Tetric EvoCeram composite, eighteen restorations showed closely adapted with no detectable margin, one restoration showed crevice with no exposed dentin and one restoration showed crevice with exposed dentin.

The anatomic form: The data for anatomic form were shown in Table (6). After one year, eighteen EQUIA Forte Fil restorations showed continuous with existing anatomic form and two restorations showed discontinuity but dentine is not exposed. For IonoStar Molar, fifteen restorations showed continuity with existing anatomic form, three restorations showed discontinuity but dentin is not exposed and two restorations showed discontinuity and dentin is exposed. For Tetric EvoCeram composite, nineteen restorations showed continuity with existing anatomic form and one restoration showed discontinuity but dentin is not exposed.

The color match: The data for the color match were shown in Table (7). After one year, seventeen EQUIA Forte Fil restorations showed matching adjacent tooth structure, two restorations showed slight mismatch and one restoration was esthetically unacceptable. For IonoStar Molar, sixteen restorations showed matching adjacent tooth structure and three restorations showed slight mismatch and one restoration was esthetically unacceptable. For Tetric EvoCeram eighteen restorations showed matching adjacent tooth structure and two restorations showed slight mismatch.

The surface texture: The data for surface texture were shown in Table (8). After one year, seventeen EQUIA Forte Fil restorations showed smooth surface, one restoration showed coarse and gritty surface and two restorations showed pitted surface. For IonoStar Molar, eighteen restorations showed smooth surface and two restorations showed coarse and gritty surface. For Tetric EvoCeram nineteen restorations showed smooth surface and one restoration showed gritty surface.

Secondary caries: After one year, nineteen EQUIA Forte Fil restorations showed no caries and one restoration showed presence of caries. For IonoStar Molar, seventeen restorations showed no caries and three restorations showed presence of caries. For Tetric EvoCeram nineteen restorations showed no caries and one restoration showed presence of caries.

Postoperative sensitivity: The data were listed in Tables (10), (11) and (12). For group 1, after six months showed one restoration with postoperative sensitivity and two restorations after one year. For group 2, after six months showed three restorations with postoperative sensitivity and four restorations after one year. For group 3, no restorations showed postoperative sensitivity at six months and only one restoration at one year with no significant difference for all groups illustrating P-values of (0.548), (0.677) and (0.311) respectively.

Table (2) Results for retention rate of the restorations at baseline, 6 months and one year.

Retention rate									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	1	5		
Group 2	Alpha	20	100	20	100	17	85	6.316	0.043*
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	3	15		
Group 3	Alpha	20	100	20	100	20	100	------	----------
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	0	0		
Duration comparison	χ^2	------		------		1.745		------	----------
	P-value	------		------		0.418		------	----------

Gp 1: EQUIA Forte Fil *Gp 2: IonoStar Molar* *Gp 3: Tetric EvoCeram* Significant P value should be P≤0.05

Table (3) Results for restoration fracture of the restorations at baseline, 6 months and one year.

Restoration fracture									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	1	5		
Group 2	Alpha	20	100	20	100	17	85	6.316	0.043*
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	3	15		
Group 3	Alpha	20	100	20	100	20	100	------	----------
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	0	0		
Duration comparison	χ^2	------		------		1.745		------	----------
	P-value	------		------		0.418		------	----------

Gp 1: EQUIA Forte Fil *Gp 2: IonoStar Molar* *Gp 3: Tetric EvoCeram* Significant P value should be P≤0.05

Table (4) Results for Marginal discoloration of the restorations at baseline, 6 months and one year.

Marginal discoloration									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	1	5		
	Charlie	0	0	0	0	0	0		
Group 2	Alpha	20	100	19	95	16	80	7.473	0.113
	Bravo	0	0	1	5	1	5		
	Charlie	0	0	0	0	3	15		
Group 3	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	1	5		
	Charlie	0	0	0	0	0	0		
Duration comparison	χ^2	------		2.034		4.833		------	----------
	P-value	------		0.362		0.305		------	----------

Gp 1: EQUIA Forte Fil *Gp 2: IonoStar Molar* *Gp 3: Tetric EvoCeram* Significant P value should be P≤0.05

Table (5) Results for marginal adaptation of the restorations at baseline, 6 months and one year.

Marginal adaptation									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	20	100	18	90	4.138	0.126
	Bravo	0	0	0	0	2	10		
	Charlie	0	0	0	0	0	0		
Group 2	Alpha	20	100	19	95	16	80	6.473	0.167
	Bravo	0	0	1	5	2	10		
	Charlie	0	0	0	0	2	10		
Group 3	Alpha	20	100	20	100	18	90	4.138	0.388
	Bravo	0	0	0	0	1	5		
	Charlie	0	0	0	0	1	5		
Duration comparison	χ^2	------		2.034		2.554		------	----------
	P-value	------		0.362		0.635		------	----------

Gp 1: EQUIA Forte Fil *Gp 2: IonoStar Molar* *Gp 3: Tetric EvoCeram* Significant P value should be P≤0.05

Table (6) Results for anatomic form of the restorations at baseline, 6 months and one year.

Anatomic form									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	20	100	18	90	4.138	0.126
	Bravo	0	0	0	0	2	10		
	Charlie	0	0	0	0	0	0		
Group 2	Alpha	20	100	19	95	15	75	8.278	0.082
	Bravo	0	0	1	5	3	15		
	Charlie	0	0	0	0	2	10		
Group 3	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	1	5		
	Charlie	0	0	0	0	0	0		
Duration comparison	χ^2	------		2.034		5.500		------	----------
	P-value	------		0.362		0.240		------	----------

Gp 1: EQUIA Forte Fil *Gp 2: IonoStar Molar* *Gp 3: Tetric EvoCeram* Significant P value should be P≤0.05

Table (7) Results for color match of the restorations at baseline, 6 months and one year.

Color match									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	19	95	17	85	4.250	0.373
	Bravo	0	0	1	5	2	10		
	Charlie	0	0	0	0	1	5		
Group 2	Alpha	20	100	19	95	16	80	7.473	0.113
	Bravo	0	0	1	5	3	15		
	Charlie	0	0	0	0	1	5		
Group 3	Alpha	20	100	20	100	18	90	4.138	0.126
	Bravo	0	0	0	0	2	10		
	Charlie	0	0	0	0	0	0		
Duration comparison	χ^2	------		2.034		1.403		------	----------
	P-value	------		0.362		0.844		------	----------

Gp 1: EQUIA Forte Fil *Gp 2: IonoStar Molar* *Gp 3: Tetric EvoCeram* Significant P value should be P≤0.05

Table (8) Results for surface texture of the restorations at baseline, 6 months and one year.

Surface texture									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	19	95	17	85	5.250	0.263
	Bravo	0	0	1	5	1	5		
	Charlie	0	0	0	0	2	10		
Group 2	Alpha	20	100	18	90	18	90	2.143	0.343
	Bravo	0	0	2	10	2	10		
	Charlie	0	0	0	0	0	0		
Group 3	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	1	5		
	Charlie	0	0	0	0	0	0		
Duration comparison	χ^2	------		2.105		4.611		------	----------
	P-value	------		0.349		0.330		------	----------

Gp 1: EQUIA Forte Fil ***Gp 2: IonoStar Molar*** ***Gp 3: Tetric EvoCeram*** **Significant P value should be P≤0.05**

Table (9) Results for secondary caries of the restorations at baseline, 6 months and one year.

Secondary caries									
Groups	Score	Baseline		After 6 months		After 12 months		χ^2	p-value
		N	%	N	%	N	%		
Group 1	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	1	5		
Group 2	Alpha	20	100	19	100	17	85	6.316	0.043*
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	1	0	3	15		
Group 3	Alpha	20	100	20	100	19	95	2.034	0.362
	Bravo	0	0	0	0	0	0		
	Charlie	0	0	0	0	1	5		
Duration comparison	χ^2	------		2.034		1.745		------	----------
	P-value	------		0.362		0.418		------	----------

Gp 1: EQUIA Forte Fil ***Gp 2: IonoStar Molar*** ***Gp 3: Tetric EvoCeram*** **Significant P value should be P≤0.05**

Table (10) Postoperative sensitivity for group 1 EQUIA Forte Fil

Postoperative sensitivity group 1				
Score	Yes		No	
	N	%	N	%
After 6 months	1	5	19	95
After 12 months	2	10	18	90
χ^2	0.360			
P-value	0.548			

Significant P value should be P≤0.05

Table (11) Postoperative sensitivity for group 2 IonoStar Molar

Postoperative sensitivity group 2				
Score	yes		No	
	N	%	N	%
After 6 months	3	15	17	85
After 12 months	4	20	16	80

χ^2	0.173
P-value	0.677

Significant P value should be P≤0.05

Table (12) Postoperative sensitivity for group 3 Tetric EvoCeram

Postoperative sensitivity group 3				
Score	yes		No	
	N	%	N	%
After 6 months	0	0	20	100
After 12 months	1	5	19	95
χ^2	1.026			
P-value	0.311			

Significant P value should be P≤0.05

IV. Discussion

The introduction of Glass Ionomer was connected with the hope of being able to replace amalgam. Especially in Europe, this was an interesting aspect because amalgam was increasingly ignored, with many amalgam restorations having been replaced by Glass Ionomer. Therefore, Glass Ionomer may become more reliable restorative material in minimally invasive dentistry based on adhesive techniques. However these materials still provide opportunities for improvement, there are still several attempts to improve their mechanical properties to be used as a dental filling material [14].

EQUIA system was introduced to be used as permanent restoration materials[13], [15], in posterior teeth with a highly dispersed nanofilled resin coating that has been introduced to increase the resistance of the glass ionomer restoration and enhance marginal sealing and therestoration esthetics[13]. Several *in vitro* tests showed that this coating had a beneficial impact on fracture strength and the early wear on GIC [16], [17].

Fuhrmann et al,[18] evaluated the fracture toughness and surface hardness of newer glass-ionomer restorative materials that are marketed for posterior stress-bearing areas compared with more traditional glass-ionomer restorative materials marketed for non–load-bearing areas and composite-resin restorative materials. The results showed that fracture toughness was not improved with the newer glass-ionomer restorative materials marketed for stress-bearing areas compared to the conventional glass-ionomer materials, however a resin coating provided greater surface hardness.

Very few clinical studies were published about GICs in permanent premolars and molars [19]. Other studies showed disappointing results when GICs were applied in large cavities and better results when GICs were applied in minimum intervention cavities [19]. Studies on the clinical performance of EQUIA Forte Fil in occlusal cavities in permanent molars reported good results when EQUIA forte Fil was applied in Class I and average Class II cavities [20].

In our clinical trial, we compared two high-viscosity Glass ionomer restorative materials IonoStar Molar with LC varnish, EQUIA Forte Fil with a nanofilled resin coating and a nano hybrid composite Tetric EvoCeram which have been used as a control group.

Both glass ionomer materials showed good overall performance in Class I cavities, EQUIA Forte Fil system with a nanofilled resin coating showed better overall clinical performance with fewer failures in all the follow-up intervals. This is maybe due to the nanofilled resin coating, which permits an improved initial stabilization of the filling material and improved infiltration and closure of the surface defects within the glass ionomer restoration [21].

The manufacturer indicates that EQUIA Forte Fil can be used as permanent filling materials in Class I and Class II cavities. IonoStar Molar GI was developed for the restoration of small and non–stress-bearing Class I restorations, and this can make it less successful in moderate-size to large restorations. In this clinical study, isolation is a must using a rubber dam, therefore results showed acceptable clinical success for each material after one year.

Concerning the anatomic form, it is maintained by the ability of the restoration to resist the wear promoted during the masticatory process, abrasive food and tooth-brushing [22]. The chemical composition, type, and amount of filler can alter the wear on restorations. The reduced filler content increases the polishing property but reduces the overall wear resistance [23]. The alpha score for EQUIA Forte Fil was (90%) and only (10%) bravo score after one year, and for Tetric EvoCeram composite restorations which achieved (95%) alpha rating may be an indication for the success of these materials to resist wear more than IonoStar Molar GI which showed less satisfied results of (75%) alpha rating and 15% bravo.

For secondary caries, it was considered to be the most common reason for the replacement of restorations [24]. After one year, only one restoration (5%) of EQUIA Forte Fil, 3 restorations (15%) of

IonoStar Molar and one restoration of Tetric EvoCeram composite showed presence of secondary caries and these restorations were replaced. The alpha scores for secondary caries could be due to the good oral hygiene status of the patients and fluoride release.

However, the incidence of secondary caries associated with some restorations could be explained on the basis of microbiological findings, higher proportion of streptococcus mutans was found at the cavity margins of the restorations may be another reason for secondary caries, highly technique sensitive and the ultimate clinical outcome is highly affected by the oral hygiene of the patients [25]Polymerization shrinkage of composite may also be a reason for secondary caries formation[25]. Microleakage due to poor adhesion and wetting, mechanical loading and thermal stresses can lead to discoloration and secondary caries [26]. Bago Juric *et al.*,[27]evaluated the clinical performance of EQUIA fil glass-ionomer cement with coating in permanent teeth within 12 months and found no secondary caries or postoperative sensitivity.

For marginal discoloration, for ideal restoration, it should have no visual evidence of marginal discoloration different from the color of the restorative material and from the color of the adjacent tooth structure however it was observed in a few restorations. After one year, EQUIA Forte Fil showed (95%) alpha rating, (80%) for IonoStar Molar and (95%) for Tetric EvoCeram composite. The staining appeared to be superficial discoloration, and although it was not significantly different, it mainly occurred in IonoStar Molar restorations rather than in the EQUIA Forte Fil restorations or Tetric EvoCeram restorations. The discolorations could be as a result of food consumption or related to pigment absorption from dietary habits or might be due to the adhesive system used in composite restoration.

Microleakage at the marginal area of composite resin restorations can lead to discoloration and secondary caries [26] and this may be due to polymerization shrinkage, formation of microcracks at the margins differences in the coefficient of thermal expansion between the composite resin and the tooth structure; use of non-incremental layering techniques; and inadequate finishing and polishing procedures [26], [28]. Gurgan *et al.*[14] reported clinically acceptable moderate marginal discolorations in EQUIA and Gradia restorations at one year

Concerning the color match,it was within the alpha range and the color stability for all restorative materials was good, indicating no mismatch in color between the restorations and adjacent teeth. However, the presence of a color mismatch between the restoration and the tooth structure was within the normal range of tooth color and the color stability of the material was acceptable after one year of clinical performance. Although this criteria is a subjective observation due to lighting conditions, chameleon effects and surface staining. Similar to our results, Diem *et al.*,[13] found that the color match of all of the restorations was assessed as 'good' when compared composite resin with the EQUIA system.

For marginal adaptation, the coefficient of thermal expansion of glass ionomer cement is almost similar to that of the tooth [29]. The manufacturer claimed that the cavity conditioner improves the adhesion, creates mechanical retention and enhances marginal seal. These properties may be responsible for EQUIA Forte Fil GI showing good marginal seal. Alpha rating after one year for Tetric EvoCeram composite restoration was (90%) and for EQUIA Forte Fil (90%) so the hybrid resin composite system and EQUIA Forte system showed the best results.

Frankenberger *et al*,[19] reported a significant changes over time were found for the criteria "surface roughness" and "marginal integrity" in clinical study of highly viscous glass ionomer cement Ketac Molar in Class I and Class II cavities.

For the surface texture, most of the materials have smooth surface textures and all three materials showed overall good results although a rough surface texture of some restorations that may be affected by acids of low pH[30]. or finishing and polishing procedures [31] . The surface roughness of restorative materials is often used to determine the wear of a material. Increased roughness might be a causative factor to microbial colonization increases the risk of oral diseases. Besides, increase in surface roughness might indicate material deterioration [32].

An increase in surface roughness can also be responsible for alterations in light reflection that can turn material surface opaque and the restorations become unaesthetic because of staining and color changes resulting from loss of reflectivity [33]. The application of G-Coat to EQUIA forte Glass ionomer was useful in reducing wear in occlusal cavities. According to the study performed by Gurgan *et al.*,[14] no significant change was found for the surface texture of glass ionomer or composite restorations after four years of clinical performance.

Concerning retention and fracture, many factors such as the cavity size has been reported to influence the survival rate of these restorations[34], [35] as reduction in cavity size will protect the restoration of the chewing forces. Low abrasion resistance, inferior strength, toughness, fatigue performance and brittleness of these materials which limit their use in the load-bearing posterior region[11]. Any restorations with fracture or retention loss were replaced immediately. Radu *et al.*,[36] reported that GIC restorations displayed five times higher risk of losing retention than composite restorations. Klinke *et al*,[37] reported fractures in Class I and

Class II fillings within the first 2 years and in the third and fourth years, while Gurgan *et al*,[14] reported a 100 % success rate for EQUIA fillings in Class I cavities and about 7 % marginal fractures in Class II fillings.

For post-operative sensitivity, alpha rating of EQUIA restorations could be due to good adaptation and aluminum chloride hexahydrate in the cavity conditioner that seal dentinal tubules and reduce the risk of post-operative sensitivity. However post-operative sensitivity could be due to defective marginal adaptation of some restorations or fractured restorations. Also, restorations that placed in deep cavities are associated with more pulpal problems including postoperative sensitivity. More accepted pulpal hydrodynamic theory a gap between dentin and restoration permits the slow outward movement of dentinal fluid and inward leakage of microbial products. Thermal or mechanical stimuli cause a sudden movement of this fluid, which is perceived by the patient as pain [38]. Postoperative sensitivity could be attributed to faulty technique rather than a deficiency in the material [39]. Against our results, Gurgan *et al*.,[14] no patient at any time interval experienced pain or sensitivity from the restored teeth.

V. Conclusion

Within the limitations of the study, we can conclude that no significant difference in performance was found between the two glass ionomer materials. The clinical performance of EQUIA Forte Fil with a nanofilled resin coating showed a slightly better overall performance than the IonoStar Molar with the light curing varnish for Class I restorations in which clinical performance is particularly challenging.

Recommendations:

These results should be confirmed by long-term clinical studies as 12 months is a short period for changes to be noticeable for the restorations.

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