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Clinical comparative study of post-operative sensitivity between giomer, Nano hybrid composite, Compomer and RMGIC

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Abstract

Objective: The aim of this clinical study is to evaluate the postoperative sensitivity in class I restorations when restored with either Nano hybrid composite, Giomer, Compomer or RMGIC.

Materials and Methods: The sample of study consisted of 15 patients; each one has four molars at least with type I caries. The patients were divided into four groups: Group A includes molars restored with Composite, Group B: molars restored with Giomer, Group C: molars restored with Compomer, and Group D: molars restored with RMGIC, no matter that they are maxillary and mandibular molars. Class I cavity was prepared with specific dimensions on the occlusal surface only. The cavities in Group A were restored with Nano hybrid composite (Tetric Evo Ceram, Ivoclar Vivadent, Ellwangen, Germany) while those in Group B were restored with Giomer (Beautifil II, Shofu, Japan), the cavities in Group C were restored with Compomer (Ivoclar) whereas those in Group D were restored with RMGIC (FUJI II LC,GC). Post-operative sensitivity has been evaluated during different follow-up periods: 3 days, 7 days, 3 weeks and 7 weeks, using the Visual Analogue Scale (VAS).

Results: No statistical difference was observed between Beautifil II, Tetric Evo Ceram, Compomer and RMGIC restorations in terms of post-operative sensitivity during the follow-up periods.

Keywords: Nano hybrid composite, Giomer, RMGIC, Compomer, postoperative sensitivity

1. Introduction

Interest in restorative dentistry has begun to develop as a preservation method for intact dental tissues. Whereas, the need for restorations that closely mimic the functional and aesthetic qualities of intact dental tissues necessitated attention to cosmetic dentistry (1990 Lundin) [30]. Actually, the industry has witnessed some significant advancements in the field of dental restorative materials, and thus preserving teeth for longer periods (Setien 2003) [46].

However, the growing aesthetic requirements of patients led to a remarkable usage increase in aesthetic restorative materials in conservative dentistry, and thus they become the most commonly used nowadays. This resulted in an accelerated development of the mechanical and cosmetic properties of restorative materials (Marghalani 2010) [33]. Several materials have been developed to cover various clinical indications, and the use of the composite resin has become possible to restore the interior and posterior teeth where a solid conjunction with the enamel and the dentin is critically required to prevent marginal microleakage between the tooth and the restorative material as well as to maintain the dimensional stability (Mitchell Ch 2008). However, problems associated with the use of composite resin in restoring posterior teeth were observed. The most important of which was the polymerization shrinkage accompanying the restoration processes, causing postoperative sensitivity of the restoration (Mount 2016) [35].

Some studies have shown that composite resin restorations are associated with postoperative sensitivity whose percentage ranges between 11% and 65%, and hence cosmetic restoration becomes worthless in case the patient reported feeling pain (Wiegand 2007) [54]. Therefore, several studies have recently addressed new restorative materials such as Giomer and resin modified glass-ionomer cement (RGMIC) and Compomer to obtain better adhesion to dental tissues and to achieve good aesthetic requirements (Schramm 2012) [45].

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Clinical research has been conducted with the aim of understanding the mechanical and clinical properties as well as expecting the durability of materials used in oral cavity fillings (Barnes 1991)^[10]. According to the National Institute of Dental and Craniofacial Research (NIDCR) in Spain, clinical research refers to clinical trials and experiments that involve human participants to provide answers for specific scientific questions in order to figure out the best prevention methods, diagnose or treat disease, and improve patient care (National Institutes Of Health, Spain, 2015)^[37].

The aforementioned factors prompted us to do this clinical research, maybe we could help determine which cosmetic restorative materials are safe to be placed in the oral cavity.

1.1 Research Significance and Objectives

The research derives its significance from the dentist's daily need for effective, easy-to-use restoration materials that are produced according to authenticated scientific bases as provided in the Arts in Medicine and capable of achieving desired goal in helping restore prepared cavities without marginal microleakage and the postoperative sensitivity and thus protecting the pulp tissue, where the clinical practitioner has great difficulty providing justifications after simple Class I cavity restorations.

1.2 Objective

The objective of this study is to compare the incidence of postoperative sensitivity in Class I cavity restorations using Giomer (Beautifil II manufactured by Shofu Dental Corporation, Japan), Nanohybrid composite (Tetric EvoCeram provided by Ivoclar Vivadent, Ellwangen, Germany), resin modified glass ionomer cement (FUJI II LC) and Compomer (Compoglass F manufactured by Ivoclar Vivadent).

1.3 Literature Review

The dentinal hypersensitivity following tooth preparation is a common problem that the dentist often faces. It is defined as a "short, sharp pain arising from exposed dentin in response to stimuli; that usually cannot be attributed to any other form, dental defect or pathology". The dentinal sensitivity affects people between the ages of 20 and 49, particularly those aged between 30 and 39 years (Pashl 2008)^[39], and it may reach high levels up to 98% in patients undergoing endodontic treatments.

The failure of the restorative materials to achieve complete marginal sealing will lead to microscopic crack formation which, in turn, will cause a leakage of electrolytes, fluids and some bacteria triggering postoperative sensitivity of restoration, secondary caries and endodontic injuries (Al-Dahan 2012)^[4]. Sensitivity frequently occurs after conservative restorations with resin composite. Clinically, this postoperative sensitivity is considered one of the common problems that may negatively affect the patient's experience towards dental treatments (Branstorm 1984)^[15], posing real dental challenge. The degree of sensitivity is affected by several factors such as the practitioner's skill and expertise, application technique of the bonding system, polymerization shrinkage and marginal microleakage. Sensitivity occurs due to the polymerization shrinkage which the restoration undergoes (Umer 2011)^[49], or it might be because of marginal microleakage (Akpata 2006)^[2] or acid etching, the failure of bod material to completely cover the exposed dentin tubules in the prepared surface.

Due to this volume shrinkage, the adhesive material will be subjected to shear bond strength at the tooth-restoration interfacial area. When the polymerization shrinkage exceeds the bond strength to the cavity walls, it causes gaps to be formed at the tooth-restoration interface (Irie 2014)^[27], the gaps are filled with dentinal fluid within 24 - 36 hours of restoration (De Munck 2005)^[20]. The movement of fluid inside the dentin tubules upon exposure to heat or cold causes the postoperative sensitivity (Summitt2013)^[48]. Some studies have reported that the patient under treatment that has a subsequent sensitivity to restoration during the first month after treatment is more likely to have a restoration failure within five years of its application (Umer 2011)^[49] and the appropriate treatment for the postoperative sensitivity may to be replaced (Summitt 2013)^[48].

Khalil's study in 2011 included 125 prepared Class I cavities to compare total-etching and self-etching systems. He found that cavities using self-etching adhesives are less sensitive than those using total-etching adhesives, particularly during the first few weeks, as well as no significant difference was observed between the two systems over a long period of time after conservative restorations (Khalil 2011).

In a study conducted by Abboud in 2017, 50 Class I cavities were involved to compare two different bonding systems using Tetric N-Ceram composite. The occurrence percentage of postoperative sensitivity following the use of Tetric N-Ceram composite reached 32% after 48 hours, 24% after a week and 8% after a month (Abboud 2017). This goes in line with Akpata's study in 2001 which involved the application of composite restorations on Class I cavities for 44 patients. percentage of sensitivity was 40% after 24 hours, 27% after a week and 20% after a month (Akpata 2001)^[3]. Meanwhile, the study conducted by Bhatti in 2014 on 292 Class I cavities using Filtek Z250 composite showed that the percentage of sensitivity reached 13% after 48 hours for patients whose average age is 35 years. This indicated a narrowing of dentinal tubules, which in turn results in reducing the occurrence of hydrodynamic movement (Bhatti 2014)^[13].

On the other hand, Opodam revealed that 14% of postoperative sensitivity of posterior composite restorations was manifested after the application of single layer technique (Opodam 1998). The lab studies showed that the use of Nano-hybrid composite resin produces less polymerization shrinkage and consequently less postoperative sensitivity (Chen 2006)^[18]. Gordan evaluated 26 Class I cavity restorations and 35 Class II cavity restorations using Beautifil II composite for 31 patients throughout 8 years. After 8 years, 16 Class I patients and 25 Class II patients visited him, none of whom exhibited any symptoms of postoperative sensitivity (Gordan 2007)^[24]. Wilson has followed up 72 Class II restorations and 36 Class I restorations in which Beautifil was used over a period time of 3 years. He concluded that Giomer restorations are capable of maintaining their clinical qualities where only 5 restorations were as failures while the sensitivity was 100% absent (Wilson 2006)^[56].

In 2004, Matis reported no statistical differences between Giomer and Nanohybrid composite in his 3-year study comparing the performance of the two materials in terms of postoperative sensitivity in Class V restorations (Matis 2004)^[34]. Amin's study in 2015 was conducted with the participation of 80 patients with Class I caries in premolars. Self-etching adhesive composite was applied on 40 patients while total-etching adhesive composite was used in the other group. 1-day, 4-day, 7-day follow-up period showed that total-etching bonding systems are less sensitive than self-etching bonding systems. He also reported that sensitivity has

almost completely disappeared in both groups after 7 days with statistically significant differences between the first and seventh day (Amin 2015) ^[6]. This finding was confirmed by Browning's study in 2017 which was conducted with the participation of 76 patients after being divided into two groups: the first group was treated with self-etching adhesive composite while the second group was treated with total-etching adhesive composite. He found that sensitivity disappeared after 13 weeks in all bonding systems whether self-etching or total etching (Browning 2007) ^[16].

Clinical studies showed that Giomer is similar to composite in terms of postoperative sensitivity of restoration, the marginal adaptation and anatomical model while the use of Giomer was associated with less secondary caries compared to composite, according to Choi's reference study (Choi 2019) ^[19]. In his study in 2016, Walia has selected 60 Class V cavities which have been restored with Ketac Molar as traditional glass-ionomer cement, Giomer, Zirconomer (Zirconia Reinforced Glass Ionomer) and Ceram-x.

The results indicated that the percentage of marginal microleakage in Giomer was the highest among the four materials, and thus causing higher postoperative sensitivity of restoration (Walia 2016) ^[53]. The study conducted by Yadaf *et al* in 2017 which involved 40 Class I cavities in primary teeth with the aim of comparing Compomer, resin-reinforced glass ionomer cement, Giomer and Ormocer (whose structure is similar to nanohybrid composite). Giomer showed the highest marginal microleakage value while the lowest microleakage value was recorded for Ormocer. The order of these materials, in regard to marginal microleakage from the lowest to the highest as follows: Ormocer, Compomer, resin-reinforced glass ionomer cement, then Giomer. This may attributed to the fact that the Compomer used in this study has chemical and optical polymerization and it exists in two separate containers. They are mixed when injected (Gunjan 2012) ^[26].

In Kauran's study conducted in 2007 and which consisted of 80 Class I and II cavities to evaluate the postoperative sensitivity of restoration, the results showed that self-etching adhesive composite restorations exhibited remarkable decrease in cold-stimulus values (Bhagwat 2007) ^[12]. While the study conducted in 2011 by Jyothi and its colleagues on 33 patients in which a comparison was made between resin-reinforced glass ionomer cement (Fuji II LC) RMGIC and Giomer (Beautify II). No postoperative sensitivity was observed in any type (Jyothi 2011) ^[29].

In 2017, Priyadarshini *et al* conducted a study to compare Fuji II LC with Beautifil II Giomer. 20 patients with 120 nonnecrotic cervical lesions were involved in the study which showed no postoperative sensitivity of restoration at 1 day, 6-month, 12-month follow-up intervals (Bollu 2017).

In a study conducted by Ergüçüa in 2007, a comparison has been made between Nanohybrid composite and Nanofilled Resin Composite (Filtek Supreme). 30 patients with 49 Class I cavities and 47 Class II cavities participated in the study which showed that no postoperative sensitivity of restoration was observed in any of the sample groups throughout the follow-up periods extending from the first day of restoration and at intervals of 6, 12 and 18 months (Ergüçüa). Meantime, the study conducted by Mahmoud in 2008 ^[31] with the participation of 35 patients with 4 Class I cavities aimed at comparing between Nanohybrid composite (Tetric EvoCeram), Ormocer, Microhybrid and Nanofilled composites. It founded no sensitivity in the Nanohybrid composite at 6 months, 1 year, or 2 years postoperatively (Mahmoud 2008) ^[31].

Jan's study in 2001 which involved 162 Class II caries filled with Nanohybrid composite (Ceram X; Dentsply). After 4 years, postoperative sensitivity was observed in 6 restorations only within the first three weeks of follow-up period (Jan

2011) ^[28].

In 2019, the study by CHOI *et al* compared the Filtek Z250 Microhybrid resin composite, Dyract XP Compomer and Beautifil II Giomer in terms of physical properties. It showed that resin-modified glass-ionomer cement has chemically adhered to dental tissues and prevented the marginal microleakage of fluids towards the restored surface, and thus it causes less sensitivity (CHOI 2019) ^[19].

Several studies showed that Compomer displayed the lowest degrees of marginal leakage compared to composite and glass-ionomer in the abovementioned studies while he highest mean score of leakage was recorded in glass-ionomer (Morabito 1997) ^[59] (Welbury 2000) ^[60] (Sikri 2002) ^[61] (Ma li 2006) ^[62].

The study by Toledano *et al.* in 1999 ^[63] was conducted on 30 Class V cavities prepared on molar teeth at laboratory, comparing between resin-modified glass ionomer cement (RMGIC) manufactured by FUJI II LC and Dyract Compomer. It showed that Compomer displayed higher marginal microleakage than resin-modified glass ionomer cement (Toledano 1999) ^[63].

Vaid *et al.* clinical study in 2015 included a clinical evaluation of resin-modified glass ionomer cement (FUJI II LC) and Nanohybrid composite (Tetric N Ceram) on nonnecrotic cervical necrosis in 87 samples. No statistically significant difference was observed between the two materials in terms of performance and the longevity of restoration at all follow-up intervals: 1, 5, 12 months (Vaid 2015) ^[64].

The study of Brackett *et al* in 2003 was conducted on 27 pairs of teeth with non-carious cervical lesions with the aim of comparing resin-modified glass ionomer cement (FUJI II LC) with Z 250 UNIVERSAL composite. No statistically significant differences were observed between the applied composite and resin-modified glass ionomer cement after two years of clinical follow-up (Brackett 2003) ^[65].

Dutra *et al* study in 2012, conducted on 92 teeth with non-carious cervical lesions, showed that the postoperative sensitivity of restoration has completely decreased in regard to tested materials: FUJI II LC and Ketac Nano (3M ESPE) at 6-month and 12-month follow-up intervals (Dutra 2012) ^[66].

2. Materials and Methods

The research used the following:

1. Nanohybrid Composite: Tetric Evo Ceram (manufactured by Ivoclar Vivadent, Ellwangen, Germany).

Fig 1: Nanohybrid Composite (Tetric Evo Ceram)

2. Bonding System (Tetric N-Bond): Manufactured by Ivoclar Vivad00000000000ent, Schaa, Liechtenstein

Fig 2: Tetric N-bond adhesive material

3. **Giomer:** Beautifil II Giomer (manufactured by Shofu Dental Corporation, Japan), resin-based restorative material that contains pre-reacted glass ionomer (PRG).

Fig 3: Giomer

4. **Giomer adhesive material (Beautibond, Shofu, Japan):** A seventh-generation one-bottle bonding agent which contains S-PRG fillers, i.e. Surface pre-reacted glass-ionomer fillers.

Fig 4: BeautiBond, Giomer bonding agent

5. **Compomer by Ivoclar (Compoglass F):** A Compomer-based light-curing dental restorative with high fluorine release and excellent esthetic properties.

Fig 5: Compoglass F

6. **Resin-modified glass ionomer (RMGIC):** GC Gold Label (manufactured by GC Corporation, Tokyo, Japan) is a glass ionomer cement to which resin is added. It contains ultra-fine particles to obtain a smooth surface and thus improving its resistance to corrosion and coloration

Fig 6: RMGIC

2 – GC Cavity Conditioner is a 20% Polyacrylic Acid solution (manufactured by GC, Tokyo, Japan) used to condition surface of the tooth prior to RMGIC application. The study sample group included 15 adolescent patients, aged between 18 and 28 years old, with 60 Class I cavities in 1st and 2nd maxillary and mandibular molars (n = 60). The cavities were conventionally prepared.

Fig 7: Polyacrylic acid

Each patient has at least four molars in which the four tested restorative materials are filled. There should be teeth adjacent and opposite to the one prepared. The patients have to maintain good oral hygiene and periodontal health. The study excluded patients with joint problems, bruxism (teeth grinding) or wrong oral habits, as well as those with previous history of cervical sensitivity, according the records of Restorative Dental Treatment Department in the Faculty of Dentistry at Hama University between 2017 and 2020. The patients were selected after a comprehensive evaluation of their cases in regard to the research form.

Fig 8: Simple Class I Caries Diagnosis

The sample has been divided into four groups

Group A: The first group includes 15 cavity preparations restored with Nanohybrid composite material (Tetric Evo Ceram manufactured by Ivoclar Vivadent, Ellwangen, Germany).

Group B: The second group includes 15 cavity preparations filled with Beautifil II Giomer restorative material (manufactured by Shofu Dental Corporation, Japan).

Group C: The third group include 15 cavity preparations restored with Compoglass F, Compomer-based restorative material manufactured by Ivoclar company.

Group D: The fourth group includes of 15 cavity preparations filled with RMGIC restorative material, Fuji II LC.

Clinical stage: Preparation and restoration were carried out in the same session after obtaining the written consent of the patient. The teeth were initially cleaned with pumice flour applied with a rubber funnel to remove the film layer or any plaque build-up. Then the rubber markers were placed on the diamond burs to determine a working length of 2 mm. A Class I cavity was prepared with the following dimensions: a 2-mm buccolingual width, a 4-mm mesial-distal width and a 2-mm depth towards the pulp. The cavity dimensions were measured with a graduated periodontal probe, making use of the location of the rubber marker on the diamond bur without edge beveling.

Fig 9: Class I Cavity Preparation

The enamel edges of the prepared cavity were etched for a

total of 30 seconds, the dentine for 15 as provided by the manufacturing company. Later on, cavities were washed for 30 seconds and then excess water with a 2-3 second gentle air burst.

Fig 10: Etching material applied on cavities prepared to be filled with Nanohybrid composite

Regarding the composite and Compomer, Appropriate amount of bonding material was applied to all parts of the cavity, and then left for 30 seconds to allow the evaporation of the solvent, after which a gentle air burst was applied. Later on, the LED light curing device (Bulgaria BG Light Ltd LED type) was used to cure restorations with a light intensity of up to MW / cm^2 1300 and a wavelength of 450-490 nm for 20 seconds in each cavity.

Fig 11: Bond Material Application

Once, the bonding material was cured, cavities were restored with Tetric EvoCeram material using Incremental Technique as recommended by (Summitt 2011) [48]. The occlusal surface was well-formed after which the occlusion has been checked and adjusted using articulating paper and diamond burs. Finishing process was carried out with FO-32EF burs accompanied with water spray while rubber burs (by Ivoclar Vivadent) were used in tooth polishing.

Fig 12: Final Restoration

In regard to Giomer, the self-etching adhesive material (BeautiBond) was applied for 30 seconds, after which a slight air-stream was applied, then it was light-cured for 10 seconds. The prepared cavities were restored with Giomer and then light-cured for 40 seconds and finished just like any composite restoration. The resin-modified glass ionomer cement (RMGIC), the cavity surface was prepared using the Cavity Conditioner, a 20% Polyacrylic Acid solution, which was placed in the cavity for 10 seconds and then rinsed with water for 15 seconds and gently dried with air spray, after which the cavity was filled with RMGIC restorative as provided by the manufacturing company and then light-cured for 40 seconds.

The patients' response was then evaluated clinically, by placing the dental unit syringe at a distance of 2 cm from the treated tooth, not to exceed 15 seconds (Perdigão 2004) and recording the degree of sensitivity on the patient's form during the follow-up intervals: 3 days, 7 days, 3 weeks and 7 weeks using Visual Analogue Scale (VAS).

Fig 13: Visual Analogue Scale (VAS) (Mannion 2007)

The sample consisted from 60 class I restorations of 60 molars on 48 subjects aging between 17 and 26 years old. Molars were divided into 4 equal distinct groups according to Restoration Material (Giomer (Beautifil II) Group, Bonding System Tetric N-Bond Group and RMGIC (Fuji II LC) Group (Control group)). Subjects and molars distributions were like it is shown below:

3. Statistical Analysis

3.1 Sample Description

3.2 Average of subject's age

Table 1: Minimum, Maximum Average and Standard Deviation of subject's age (in years).

Studied Variable	Subjects No	Minimum	Maximum	Average	Standard Deviation
Age (in years)	15	17	26	21.3	3.0

3.3 Sample Distribution according to Restoration Material

Table 2: Sample Distribution according to Gender and Restoration Material

Restoration Material	N	Percent
Giomer (Beautifil II)	15	25.0
Bonding System Tetric N-Bond	15	25.0
Compomer (Compoglass F)	15	25.0
RMGIC (Fuji II LC)	15	25.0
Total	60	100

Fig 14: Percent of Sample Distribution according to Restoration Material.

Table 3: Sample Distribution according to Molar characteristics variables and Restoration Material

Studied Variable	Category	N					Percent				
		Giomer (Beautifil II)	Bonding System Tetric N-Bond	Compomer (Compoglass F)	RMGIC (Fuji II LC)	All Molars	Giomer (Beautifil II)	Bonding System Tetric N-Bond	Compomer (Compoglass F)	RMGIC (Fuji II LC)	All Molars
Molar Type	First Molar	15	15	0	0	30	100	100	0	0	50.0
	Second Molar	0	0	15	15	30	0	0	100	100	50.0
Molar Location	Upper	8	8	5	7	28	53.3	53.3	33.3	46.7	46.7
	Lower	7	7	10	8	32	46.7	46.7	66.7	53.3	53.3
Molar Side	Right	15	0	15	1	31	100	0	100	6.7	51.7
	Left	0	15	0	14	29	0	100	0	93.3	48.3
Molar Location & Side	Upper Right	8	0	5	1	14	53.3	0	33.3	6.7	23.3
	Upper Left	0	8	0	6	14	0	53.3	0	40.0	23.3
	Lower Left	0	7	0	8	15	0	46.7	0	53.3	25.0
	Lower Right	7	0	10	0	17	46.7	0	66.7	0	28.3

Fig 15: Percent of Sample Distribution according to Molar Type and Restoration Material.

Fig 16: Percent of Sample Distribution according to Molar Location and Restoration Material.

Fig 17: Percent of Sample Distribution according to Molar Side and Restoration Material.

Fig 18: Percent of Sample Distribution according to Molar Location & Side and Restoration Material.

3.4 Statistical Analysis Results

Post-Operative Sensitivity (POS) Degree and Post-Operative Sensitivity For Patient (POSP) Degree were observed in four different periods (After 3 days, After 1 week, After 3 weeks, After 7 weeks) for each restoration case in the sample. Both POS Degree and POSP Degree variables had 5 distinct ordinal categories, each one was assigned to a distinct numerical value, which reflects the Pain Level like it is shown in Table below:

Table 4: Assigned values to POS Degrees in the sample

POS Degree / POSP Degree	Assigned value
No Pain	0
Slight Pain	1
Moderate Pain	2
Sever Pain	3
Worst Pain Possible	4

Then, the Effects Restoration Material on both POS Degree and POS for Patient Degree frequencies were studied and the analysis results were like it is shown below:

POS Degrees Study

- **POS Degrees observation results according to Restoration Material and Studied Period**

Table 5: POS Degrees observation results according to Restoration Material and Studied Period.

Studied Period	Restoration Material	N						Percent					
		No Pain	Slight Pain	Moderate Pain	Sever Pain	Worst Pain Possible	Total	No Pain	Slight Pain	Moderate Pain	Sever Pain	Worst Pain Possible	Total
After 3 days	Giomer (Beautifil II)	12	2	1	0	0	15	80.0	13.3	6.7	0	0	100
	Bonding System Tetric N-Bond	11	3	1	0	0	15	73.3	20.0	6.7	0	0	100
	Compomer (Compoglass F)	0	13	2	0	0	15	0	86.7	13.3	0	0	100
	RMGIC (Fuji II LC)	14	1	0	0	0	15	93.3	6.7	0	0	0	100
After 1 week	Giomer (Beautifil II)	14	1	0	0	0	15	93.3	6.7	0	0	0	100
	Bonding System Tetric N-Bond	14	1	0	0	0	15	93.3	6.7	0	0	0	100
	Compomer (Compoglass F)	5	10	0	0	0	15	33.3	66.7	0	0	0	100
	RMGIC (Fuji II LC)	14	1	0	0	0	15	93.3	6.7	0	0	0	100
After 3 weeks	Giomer (Beautifil II)	15	0	0	0	0	15	100	0	0	0	0	100
	Bonding System Tetric N-Bond	14	1	0	0	0	15	93.3	6.7	0	0	0	100
	Compomer (Compoglass F)	7	8	0	0	0	15	46.7	53.3	0	0	0	100
	RMGIC (Fuji II LC)	15	0	0	0	0	15	100	0	0	0	0	100
After 1 week	Giomer (Beautifil II)	15	0	0	0	0	15	100	0	0	0	0	100
	Bonding System Tetric N-Bond	15	0	0	0	0	15	100	0	0	0	0	100

Compomer (Compoglass F)	13	2	0	0	0	15	86.7	13.3	0	0	0	100
RMGIC (Fuji II LC)	10	5	0	0	0	15	66.7	33.3	0	0	0	100

Fig 19: Percent of POS Degrees occurrence according to Restoration Material and Studied Period variables.

3.5 Effect of Restoration Material on POS Degrees according to Studied Period

A Kruskal-Wallis Test was applied to know if there were significant differences in POS Degrees between Giomer (Beautifil II) group, Bonding System Tetric N-Bond Group and RMGIC (Fuji II LC) Group according to Studied Period like it is shown below:

and RMGIC (Fuji II LC) Group according to Studied Period like it is shown below:

3.6 Kruskal-Wallis Test results

Table 6: Kruskal-Wallis Test results to know if there were significant differences in POS Degrees between Giomer (Beautifil II) group, Bonding System Tetric N-Bond Group and RMGIC (Fuji II LC) Group according to Studied Period.

Studied Period	Restoration Material	N	Mean Ranks	Chi-Square value	P-Value	Significant Diff. ?
After 3 days	Giomer (Beautifil II)	15	25.37	30.503	0.000	Yes
	Bonding System Tetric N-Bond	15	27.23			
	Compomer (Compoglass F)	15	48.53			
	RMGIC (Fuji II LC)	15	20.87			
After 1 week	Giomer (Beautifil II)	15	26.00	23.465	0.000	Yes
	Bonding System Tetric N-Bond	15	26.00			
	Compomer (Compoglass F)	15	44.00			
	RMGIC (Fuji II LC)	15	26.00			
After 3 weeks	Giomer (Beautifil II)	15	26.00	23.009	0.000	Yes
	Bonding System Tetric N-Bond	15	28.00			
	Compomer (Compoglass F)	15	42.00			
	RMGIC (Fuji II LC)	15	26.00			
After 7 weeks	Giomer (Beautifil II)	15	27.00	10.655	0.014	Yes
	Bonding System Tetric N-Bond	15	27.00			
	Compomer (Compoglass F)	15	31.00			
	RMGIC (Fuji II LC)	15	37.00			

All P-Values were lower than 0.05, so, at the confidence level of 95% there were significant differences in POS Degrees between at least two of the four studied groups (Giomer (Beautifil II), Bonding System Tetric N-Bond, Compomer (Compoglass F) and RMGIC (Fuji II LC)) whatever the

Studied Period was. A Mann-Whitney U Test was applied to know if there were significant pair-wise differences between Studied groups like it is shown below:

3.7 Mann-Whitney U Test results

Table 7: Mann-Whitney U Test results to know if there were significant pair-wise differences in POS Degrees between Giomer (Beautifil II) group, Bonding System Tetric N-Bond Group and RMGIC (Fuji II LC) Group according to Studied Period.

Studied Variable = POS Degrees					
Studied Period	Restoration Material (I)	Restoration Material(J)	U value	P-Value	Significant Diff.?
After 3 days	Giomer	Bonding System	105.5	0.694	No
		Compomer	27.0	0.000	YES
		RMGIC	97.0	0.276	No
	Bonding System	Compomer	33.5	0.000	YES

After 1 week	Compomer	RMGIC	89.5	0.141	No
		RMGIC	6.5	0.000	YES
	Giomer	Bonding System	112.5	1.000	No
		Compomer	45.0	0.001	YES
		RMGIC	112.5	1.000	No
	Bonding System	Compomer	45.0	0.001	YES
		RMGIC	112.5	1.000	No
After 3 weeks	Compomer	RMGIC	45.0	0.001	YES
		Bonding System	105.0	0.317	No
		Compomer	52.5	0.001	YES
	Giomer	RMGIC	112.5	1.000	No
		Compomer	60.0	0.006	YES
		RMGIC	105.0	0.317	No
After 7 weeks	Compomer	RMGIC	52.5	0.001	YES
		Bonding System	112.5	1.000	No
		Compomer	97.5	0.150	No
	Giomer	RMGIC	75.0	0.016	Yes
		Compomer	97.5	0.150	No
		RMGIC	75.0	0.016	Yes
	Compomer	RMGIC	90.0	0.203	No

P-Values were lower than 0.05 when comparing in POS Degrees After 3 days, After 1 week and After 3 weeks between Compomer (Compoglass F) group and all the other studied Restoration Material groups (Giomer (Beautifil II) group, Bonding System Tetric N-Bond group and RMGIC (Fuji II LC) group), and when comparing in POS Degrees After 7 weeks between RMGIC (Fuji II LC) group and both Giomer (Beautifil II) group and Bonding System Tetric N-Bond group, so, we can conclude at the confidence level of 95% that there were significant differences in POS Degrees between sub-mentioned Studied Restoration Material groups. Referring to the according Mean Ranks values we conclude

that: POS Degrees After 3 days, After 1 week and After 3 weeks in Compomer (Compoglass F) group were higher than those of all the other studied groups (Giomer (Beautifil II) group, Bonding System Tetric N-Bond group and RMGIC (Fuji II LC) group). POS Degrees After 7 weeks in RMGIC (Fuji II LC) group were higher than those of both Giomer (Beautifil II) group and Bonding System Tetric N-Bond group in the studied sample.

All other P-Values were much greater than 0.05, so, at the confidence level of 95% there were no significant differences in POS Degrees between the according subgroups in the sample.

Fig 20: Mean Ranks of POS Degrees according to Restoration Material and Studied Period.

3-8-Studied Period effect on POS according to Restoration Material variable Study

A Friedman test was applied to know if there were significant differences in POS variable's degrees frequencies between the

four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable like it is shown below:

Table 8: Friedman test results to know if there were significant differences in POS variable's degrees frequencies between the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable.

Restoration Material	Studied Period	Mean Ranks	Chi-Square value	P-Value	Significant Diff. ?
Giomer (Beautifil II)	After 3 days	2.80	8.143	0.043	Yes
	After 1 week	2.47			
	After 3 weeks	2.37			
	After 7 weeks	2.37			

Bonding System Tetric N-Bond	After 3 days	2.87	8.793	0.032	Yes
	After 1 week	2.40			
	After 3 weeks	2.43			
	After 7 weeks	2.30			
Compomer (Compoglass F)	After 3 days	3.47	27.341	0.000	YES
	After 1 week	2.60			
	After 3 weeks	2.33			
	After 7 weeks	1.60			
RMGIC (Fuji II LC)	After 3 days	2.40	9.316	0.025	Yes
	After 1 week	2.40			
	After 3 weeks	2.27			
	After 7 weeks	2.93			

All P-values were lower than 0.05, so we can conclude at 95% of confidence level that there were significant differences in POS variable's degrees between at least two of the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) whatever the studied Restoration Material was in the studied sample.

A Wilcoxon Signed Ranks test was applied to know if there were significant pair-wise differences in POS variable's degrees frequencies between the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable like it is shown below:

Table 9: Wilcoxon Signed Ranks test results to know if there were significant pair-wise differences in POS variable's degrees frequencies between the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable.

Restoration Material	Compared Periods	Z value	P-Value	Significant Diff. ?
Giomer (Beautifil II)	After 1 week & After 3 days	-1.732	0.083	No
	After 3 weeks & After 3 days	-1.633	0.102	No
	After 7 weeks & After 3 days	-1.633	0.102	No
	After 3 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 3 weeks	0	1.000	No
Bonding System Tetric N-Bond	After 1 week & After 3 days	-2.000	0.046	Yes
	After 3 weeks & After 3 days	-1.633	0.102	No
	After 7 weeks & After 3 days	-1.890	0.059	No
	After 3 weeks & After 1 week	0	1.000	No
	After 7 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 3 weeks	-1.000	0.317	No
Compomer (Compoglass F)	After 1 week & After 3 days	-2.646	0.008	YES
	After 3 weeks & After 3 days	-3.000	0.003	YES
	After 7 weeks & After 3 days	-3.419	0.001	YES
	After 3 weeks & After 1 week	-1.414	0.157	No
	After 7 weeks & After 1 week	-2.828	0.005	YES
	After 7 weeks & After 3 weeks	-2.449	0.014	Yes
RMGIC (Fuji II LC)	After 1 week & After 3 days	0	1.000	No
	After 3 weeks & After 3 days	-1.000	0.317	No
	After 7 weeks & After 3 days	-1.633	0.102	No
	After 3 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 1 week	-2.000	0.046	Yes
	After 7 weeks & After 3 weeks	-2.236	0.025	Yes

P-value was lower than 0.05 when comparing between (After 3 days and After 1 week) periods for Bonding System Tetric N-Bond group, when comparing between the period (After 3 days) and all the other studied periods (After 1 week and After 3 weeks and After 7 weeks) and when comparing between the period (After 7 weeks) and both (After 1 week and After 3 weeks) periods for Compomer (Compoglass F) group and when comparing between the period (After 7 weeks) and both (After 1 week and After 3 weeks) periods for RMGIC (Fuji II LC) group, so we can conclude at 95% of confidence level that there were significant pair-wise differences in POS variable's degrees between the sub-mentioned periods in the studied sample. Referring to Mean Ranks values we conclude that POS variable's degrees in the period (After 1 week) were lower than those of the period

(After 3 days) for Bonding System Tetric N-Bond group, POS variable's degrees in all (After 1 week, After 3 weeks and After 7 weeks) periods were lower than those of the period (After 3 days) for Compomer (Compoglass F) group, POS variable's degrees in the period (After 7 weeks) were lower than those of both (After 1 week and After 3 weeks) periods for Compomer (Compoglass F) group and POS variable's degrees in the period (After 7 weeks) were higher than those of both (After 1 week and After 3 weeks) periods for RMGIC (Fuji II LC) group in the studied sample.

All other P-values were greater than 0.05, so we can conclude at 95% of confidence level that there were no significant pair-wise differences in POS variable's degrees between the according studied Periods in the studied sample.

Fig 21: Mean Ranks of POS Degrees According to Studied Period and Restoration Material variables.

POSP Degrees Study

Restoration Material and Studied Period

- POSP Degrees observation results according to

Table 10: POSP Degrees observation results according to Restoration Material and Studied Period.

Studied Period	Restoration Material	N						Percent					
		No Pain	Slight Pain	Moderate Pain	Sever Pain	Worst Pain Possible	Total	No Pain	Slight Pain	Moderate Pain	Sever Pain	Worst Pain Possible	Total
After 3 days	Giomer (Beautifil II)	12	2	0	0	1	15	80.0	13.3	0	0	6.7	100
	Bonding System Tetric N-Bond	11	0	2	1	1	15	73.3	0	13.3	6.7	6.7	100
	Compomer (Compoglass F)	0	9	4	0	2	15	0	60.0	26.7	0	13.3	100
	RMGIC (Fuji II LC)	14	1	0	0	0	15	93.3	6.7	0	0	0	100
After 1 week	Giomer (Beautifil II)	14	0	1	0	0	15	93.3	0	6.7	0	0	100
	Bonding System Tetric N-Bond	14	0	0	1	0	15	93.3	0	0	6.7	0	100
	Compomer (Compoglass F)	5	7	1	2	0	15	33.3	46.7	6.7	13.3	0	100
	RMGIC (Fuji II LC)	14	1	0	0	0	15	93.3	6.7	0	0	0	100
After 3 weeks	Giomer (Beautifil II)	15	0	0	0	0	15	100	0	0	0	0	100
	Bonding System Tetric N-Bond	14	1	0	0	0	15	93.3	6.7	0	0	0	100
	Compomer (Compoglass F)	7	8	0	0	0	15	46.7	53.3	0	0	0	100
	RMGIC (Fuji II LC)	15	0	0	0	0	15	100	0	0	0	0	100
After 1 week	Giomer (Beautifil II)	15	0	0	0	0	15	100	0	0	0	0	100
	Bonding System Tetric N-Bond	15	0	0	0	0	15	100	0	0	0	0	100
	Compomer (Compoglass F)	13	2	0	0	0	15	86.7	13.3	0	0	0	100
	RMGIC (Fuji II LC)	10	5	0	0	0	15	66.7	33.3	0	0	0	100

Fig 22: Percent of POSP Degrees occurrence according to Restoration Material and Studied Period variables.

3.9 Effect of Restoration Material on POSP Degrees according to Studied Period

A Kruskal-Wallis Test was applied to know if there were significant differences in POSP Degrees between Giomer (Beautifil II) group, Bonding System Tetric N-Bond Group

and RMGIC (Fuji II LC) Group according to Studied Period like it is shown below:

3.10-Kruskal-Wallis Test results

Table 11: Kruskal-Wallis Test results to know if there were significant differences in POSP Degrees between Giomer (Beautifil II) group, Bonding System Tetric N-Bond Group and RMGIC (Fuji II LC) Group according to Studied Period.

Studied Period	Restoration Material	N	Mean Ranks	Chi-Square value	P-Value	Significant Diff. ?
After 3 days	Giomer (Beautifil II)	15	24.90	28.297	0.000	YES
	Bonding System Tetric N-Bond	15	28.57			
	Compomer (Compoglass F)	15	47.90			
	RMGIC (Fuji II LC)	15	20.63			
After 1 week	Giomer (Beautifil II)	15	26.17	22.003	0.000	YES
	Bonding System Tetric N-Bond	15	26.33			
	Compomer (Compoglass F)	15	43.67			
	RMGIC (Fuji II LC)	15	25.83			
After 3 weeks	Giomer (Beautifil II)	15	26.00	23.009	0.000	YES
	Bonding System Tetric N-Bond	15	28.00			
	Compomer (Compoglass F)	15	42.00			
	RMGIC (Fuji II LC)	15	26.00			
After 7 weeks	Giomer (Beautifil II)	15	27.00	10.655	0.014	Yes
	Bonding System Tetric N-Bond	15	27.00			
	Compomer (Compoglass F)	15	31.00			
	RMGIC (Fuji II LC)	15	37.00			

All P-Values were lower than 0.05, so, at the confidence level of 95% there were significant differences in POSP Degrees between at least two of the four studied groups (Giomer (Beautifil II), Bonding System Tetric N-Bond, Compomer (Compoglass F) and RMGIC (Fuji II LC)) whatever the

Studied Period was. A Mann-Whitney U Test was applied to know if there were significant pair-wise differences between Studied groups like it is shown below:

3.11 Mann-Whitney U Test results

Table 12: Mann-Whitney U Test results to know if there were significant pair-wise differences in POSP Degrees between Giomer (Beautifil II) group, Bonding System Tetric N-Bond Group and RMGIC (Fuji II LC) Group according to Studied Period.

Studied Variable = POSP Degrees					
Studied Period	Restoration Material (I)	Restoration Material(J)	U value	P-Value	Significant Diff.?
After 3 days	Giomer	Bonding System	102.5	0.576	No
		Compomer	23.0	0.000	YES
		RMGIC	97.0	0.276	No
	Bonding System	Compomer	49.0	0.006	YES
		RMGIC	88.0	0.117	No
	Compomer	RMGIC	4.5	0.000	YES
After 1 week	Giomer	Bonding System	112.0	0.962	No
		Compomer	47.5	0.002	YES
		RMGIC	112.0	0.962	No
	Bonding System	Compomer	49.0	0.002	YES
		RMGIC	112.0	0.962	No
	Compomer	RMGIC	43.5	0.001	YES
After 3 weeks	Giomer	Bonding System	105.0	0.317	No
		Compomer	52.5	0.001	YES
		RMGIC	112.5	1.000	No
	Bonding System	Compomer	60.0	0.006	YES
		RMGIC	105.0	0.317	No
	Compomer	RMGIC	52.5	0.001	YES
After 7 weeks	Giomer	Bonding System	112.5	1.000	No
		Compomer	97.5	0.150	No
		RMGIC	75.0	0.016	Yes
	Bonding System	Compomer	97.5	0.150	No
		RMGIC	75.0	0.016	Yes
	Compomer	RMGIC	90.0	0.203	No

P-Values were lower than 0.05 when comparing in POSP Degrees After 3 days, After 1 week and After 3 weeks between Compomer (Compoglass F) group and all the other studied Restoration Material groups (Giomer (Beautifil II) group, Bonding System Tetric N-Bond group and RMGIC (Fuji II LC) group), and when comparing in POSP Degrees

After 7 weeks between RMGIC (Fuji II LC) group and both Giomer (Beautifil II) group and Bonding System Tetric N-Bond group, so, we can conclude at the confidence level of 95% that there were significant differences in POSP Degrees between sub-mentioned Studied Restoration Material groups. Referring to the according Mean Ranks values we conclude

that: POSP Degrees After 3 days, After 1 week and After 3 weeks in Compomer (Compoglass F) group were higher than those of all the other studied groups (Giomer (Beautifil II) group, Bonding System Tetric N-Bond group and RMGIC (Fuji II LC) group). POSP Degrees After 7 weeks in RMGIC (Fuji II LC) group were higher than those of both Giomer

(Beautifil II) group and Bonding System Tetric N-Bond group in the studied sample.

All other P-Values were much greater than 0.05, so, at the confidence level of 95% there were no significant differences in POSP Degrees between the according subgroups in the sample.

Fig 23: Mean Ranks of POSP Degrees according to Restoration Material and Studied Period.

3-12-Studied Period effect on POSP according to Restoration Material variable Study

A Friedman test was applied to know if there were significant differences in POSP variable's degrees frequencies between

the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable like it is shown below:

Table 13: Friedman test results to know if there were significant differences in POSP variable's degrees frequencies between the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable.

Restoration Material	Studied Period	Mean Ranks	Chi-Square value	P-Value	Significant Diff. ?
Giomer (Beautifil II)	After 3 days	2.80	8.143	0.043	Yes
	After 1 week	2.47			
	After 3 weeks	2.37			
	After 7 weeks	2.37			
Bonding System Tetric N-Bond	After 3 days	2.90	9.900	0.019	Yes
	After 1 week	2.40			
	After 3 weeks	2.40			
	After 7 weeks	2.30			
Compomer (Compoglass F)	After 3 days	3.70	32.486	0.000	YES
	After 1 week	2.63			
	After 3 weeks	2.13			
	After 7 weeks	1.53			
RMGIC (Fuji II LC)	After 3 days	2.40	9.316	0.025	Yes
	After 1 week	2.40			
	After 3 weeks	2.27			
	After 7 weeks	2.93			

All P-values were lower than 0.05, so we can conclude at 95% of confidence level that there were significant differences in POSP variable's degrees between at least two of the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) whatever the studied Restoration Material was in the studied sample.

A Wilcoxon Signed Ranks test was applied to know if there were significant pair-wise differences in POSP variable's degrees frequencies between the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable like it is shown below:

Table 14: Wilcoxon Signed Ranks test results to know if there were significant pair-wise differences in POSP variable's degrees frequencies between the four studied Periods (After 3 days, After 1 week, After 3 weeks and After 7 weeks) according to Restoration Material variable.

Restoration Material	Compared Periods	Z value	P-Value	Significant Diff. ?
Giomer (Beautifil II)	After 1 week & After 3 days	-1.633	0.102	No
	After 3 weeks & After 3 days	-1.633	0.102	No
	After 7 weeks & After 3 days	-1.633	0.102	No

	After 3 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 3 weeks	0	1.000	No
Bonding System Tetric N-Bond	After 1 week & After 3 days	-1.841	0.066	No
	After 3 weeks & After 3 days	-1.826	0.068	No
	After 7 weeks & After 3 days	-1.841	0.066	No
	After 3 weeks & After 1 week	-0.447	0.655	No
	After 7 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 3 weeks	-1.000	0.317	No
	After 7 weeks & After 3 weeks	-1.000	0.317	No
Compomer (Compoglass F)	After 1 week & After 3 days	-3.162	0.002	YES
	After 3 weeks & After 3 days	-3.213	0.001	YES
	After 7 weeks & After 3 days	-3.402	0.001	YES
	After 3 weeks & After 1 week	-2.070	0.038	Yes
	After 7 weeks & After 1 week	-2.810	0.005	YES
	After 7 weeks & After 3 weeks	-2.449	0.014	Yes
	After 7 weeks & After 3 weeks	-2.449	0.014	Yes
RMGIC (Fuji II LC)	After 1 week & After 3 days	0	1.000	No
	After 3 weeks & After 3 days	-1.000	0.317	No
	After 7 weeks & After 3 days	-1.633	0.102	No
	After 3 weeks & After 1 week	-1.000	0.317	No
	After 7 weeks & After 1 week	-2.000	0.046	Yes
	After 7 weeks & After 3 weeks	-2.236	0.025	Yes
	After 7 weeks & After 3 weeks	-2.236	0.025	Yes

P-value was lower than 0.05 for all studied pair-wise comparisons for Compomer (Compoglass F) group and when comparing between the period (After 7 weeks) and both (After 1 week and After 3 weeks) periods for RMGIC (Fuji II LC) group, so we can conclude at 95% of confidence level that there were significant pair-wise differences in POSP variable's degrees between the sub-mentioned periods in the studied sample. Referring to Mean Ranks values we conclude that POSP variable's degrees in all (After 1 week, After 3 weeks and After 7 weeks) periods were lower than those of the period (After 3 days), POSP variable's degrees in both (After 3 weeks and After 7 weeks) periods were lower than

those of the period (After 1 week), POSP variable's degrees in the period (After 7 weeks) were lower than those of the period (After 1 week) for Compomer (Compoglass F) group and POSP variable's degrees in the period (After 7 weeks) were higher than those of both (After 1 week and After 3 weeks) periods for RMGIC (Fuji II LC) group in the studied sample.

All other P-values were greater than 0.05, so we can conclude at 95% of confidence level that there were no significant pair-wise differences in POSP variable's degrees between the according studied Periods in the studied sample.

Fig 24: Mean Ranks of POSP Degrees According to Studied Period and Restoration Material variables.

4. Discussion of Sensitivity Results

The ongoing development of composites and their application techniques has saw them used widely in dental clinics. This called for the need to resolve problems related to composite restorations; such as postoperative sensitivity after the application of posterior dental composite restorations which has been reported as a common problem. Also, it has been found that postoperative sensitivity decreases during the first few weeks after restoration placement, but it sometimes

persists for an extended period of time.

Postoperative sensitivity can be attributed to several factors, including etching, bacterial penetration of pulp, restoration placement technique, depth of cavity, dentin overdrying, and cusp deformation due to polymerization shrinkage stress of composite. Some research studies in medicine have revealed that postoperative sensitivity can still be found in 30% of the studied population (Auschill 2009, Berkowitz 2009, Blanchard 2013, Perdigo 2010) [9, 11, 14, 41].

Class I cavity designs were selected to demonstrate sensitivity as they have a high 'C' factor (configuration factor), i.e. there is no free, unbonded surfaces, thus they restrain the relief of stress caused by polymerization shrinkage. Moreover, the large Cavo surface angle increases the potential for marginal microleakage which in turn results in postoperative sensitivity (VAN DIJKEN 2010) ^[50]. Class I cavity preparations are relatively easy, while their variables are less than those of compounded preparations (AKPATA 2001) ^[3].

In this research study, 3 mm deep cavity preparations were made given that sensitivity tends to increase as the cavity is deepened due to the proximity to the pulp, therefore, increasing diameter and the number of dentine tubules per unit area as well as humidity (AUSCHILL 2009) ^[9]. In 2013, Asghar founded that no postoperative sensitivity was observed in cavity preparations with a depth ≥ 3 mm, meantime, percentage of postoperative sensitivity was 16.3% in 3.5-mm deep cavities and reached 46.4% in 4-mm deep cavities. (ASGHAR 2013) ^[8].

Cold test was conducted because it is viewed as the most accurate measure to determine sensitivity levels (BERKOWITZ 2009) ^[11]. Other methods were previously used to evaluate sensitivity such as cold water, ethyl chloride or putting a piece of ice on tooth surface (BROWNING 2007, AUSCHILL 2009) ^[16]. In this study, compressed cold air was applied from the dental unit syringe at a distance of approximately 2 cm to the restoration (YOUSAF 2014) ^[57].

Furthermore, the Visual Analog Scale Score (VAS) was used to evaluate the postoperative sensitivity of restoration, given that it is a measurement instrument for subjective characteristics or attitudes that cannot be directly measured. It mainly depends on the patient's response to a scale of 0–10 indicating his/her agreement or disagreement on a certain case through putting a mark on a VAS line to point out the intensity of pain with clear phrases such as "no pain" at the beginning of the scale and "worst pain" at its end (HOGGART 2005) ^[55].

At the level of average ranks within each of the groups, which were studied in terms of time period, it was found through this study: Regarding the EvoCeram, three days after restoration, 11 patients (73.3%) have shown no postoperative sensitivity, scoring /0/, 3 patients (20%) reported mild pain or discomfort (score 1) while the last remaining sample (6.7%) recorded moderate pain, (score 2).

During the follow-up period, postoperative pain was assessed 7 days after applying the restoration as well as 3 weeks later, 14 patients (93.3%) stated that they feel no pain or discomfort, scoring /0/ while the remaining part of the sample (6.7%) revealed a mild pain or discomfort, scoring /1/.

This is different from Research Mahmoud's findings in 2008 who stated that no postoperative sensitivity of restorations was observed in any of the Nanohybrid composites throughout the follow-up periods (MAHMOUD 2008) ^[31].

Moreover, through the 7-week evaluation period, no patient reported any kind of discomfort and all of the sample's patients got zero mark, i.e. the sensitivity totally disappeared after seven weeks of using EvoCeram. A statistically significant decrease in postoperative sensitivity has been reported between the third and sixth day and sensitivity has completely reduced after 6 days of using EvoCeram composites. This is also different from what Researcher Akpata found in 2011. He stated that 27% of the total sample has shown postoperative sensitivity of composite a week after restoration and sensitivity was observed at 20% of the total sample after a month (Akpata 2011) ^[3]. It varies from

Yousaf's results in 2014 who assessed the postoperative sensitivity of restoration with Te-Econom Ivoclar composite. The percentage of sensitivity reached 39% after 24 hours, 30% after a week and 5% after a month (Yousaf 2014) ^[57]. The difference between the current study and the other two can be attributed to the difference in the follow-up periods. Meantime, it agrees with Akpata's findings in regard to the decrease of postoperative sensitivity related to restorations, during follow-up period (Akpata).

The study differs from that of Abboud conducted in 2017 which revealed that the percentage of sensitivity reached 32% after 48 hours, 20% after one week and 8% after a month. The difference can be attributed to that the patients who involved in Abboud's study are younger, and so the diameter of dentinal tubules is larger which leads to an increase in the hydrodynamic movement causing greater pain (Abboud 2017).

The study's findings go in line with what Bhatti found in 2014. He stated that the percentage of sensitivity of restoration reached 13% after 48 hours, attributing that to the average age of the sample of people which is 35 years, and thus the dentinal tubules are constricted, which decreases the hydrodynamic movement (Bhatti 2014) ^[13]. The sensitivity decreases as progress made in follow-up periods. This could be attributable to the ability of bonding (adhesive) systems to induce the dental pulp to form tertiary dentin as well as the insulating properties of composite (Abboud 2017).

It also differs with Jan's study in 2001 which stated that only 6 out of 162 Class II composite restorations showed postoperative sensitivity during 4-year follow-up period.

Regarding Beautifil II, and after three days of application, 12 of the sample (80%) did not show any sign of postoperative sensitivity of restoration (score 0), while 2 of the sample (13.3%) exhibited mild pain or discomfort (score 1) and the remaining 6.7% of the sample showed moderate pain or discomfort (score 2).

During the follow-up period, (7 days, 3 weeks) 14 restorations related to the sample (93.3%) did not show any sign of discomfort (scoring 0), while the remaining 6.7% of the sample showed mild pain or discomfort (score 1).

In 3-week, 7-week follow-up period, none of the sample exhibited any signs of discomfort (scoring 0), i.e. the sensitivity has totally disappeared after three weeks of using Beautifil II composite. In other words, the postoperative sensitivity decreased in a statistically significant way between 3 to 6 days and it almost completely reduced after 6 days of Beautifil II composite restoration.

This agrees with Gordan's findings in 2007 which concluded that no postoperative sensitivity of restoration was observed in Beautifil II composite sample throughout a follow-up period of 8 years (Gordan 2007) ^[24] as well as Wislon's study conducted in 2006 in which the sensitivity disappeared from 100% of the total Beautifil II composite sample during up to 3-year follow-up period (Wilson 2006) ^[56].

It is compatible to studies of Gordan and Mjör in 2002 which investigated the postoperative sensitivity of Giomer restorations (Beautifil, Shofu Inc., Kyoto, Japan) over period of time 2 and 7 days. A postoperative sensitivity was observed in two restorations in the seventh day while other patients did not exhibit any sensitivity symptoms in the fourteenth day of follow-up (Gordan 2002) ^[25].

The study conforms to Kauran's study in 2007 conducted on 80 Class I and II cavities which revealed a decrease in the postoperative sensitivity of restoration in composites used with self-etching adhesive resin systems (KAURAK 2007).

This can be attributed to the fact that the self-etching adhesive primers create thin hybrid layers that incorporate the smear layer. They demineralize the smear layer and incorporate its remnants into a mixture of collagen fibers and resin monomers after which the smear layer becomes an integral part of the hybrid layer minimizing the occurrence of postoperative sensitivity. The same result has been shown in this study in which Giomer self-etching adhesive resin systems were used (LETZEL 1989, TANGEL 1990).

The results of the current study agree with Sunico's study conducted in 2005 which revealed that 80% of Giomer restoration sample did not show any postoperative sensitivity of restoration after 2-year follow-up period (SUNICO 2005).

Regarding Compoglass F, after three days, 13 of the Compoglass F sample (86.7%) exhibited mild pain or discomfort (score 1) while the remaining two of the sample (13.3%) showed moderate pain or discomfort (score 2).

Over a 7-day follow-up period, 5 restorations of the sample (33.3%) did not show any sign of pain or discomfort (score 0) while 10 restorations (66.7%) exhibited a mild pain or discomfort (score 1). During 3-week follow-up period, 7 restorations of the sample (46.7%) did not show any sign of pain or discomfort (score 0) while 8 restorations (53.3%) exhibited mild pain or discomfort (score 1). In 7-week follow-up period, 13 restorations of the sample (86.7%) did not show any sign of pain or discomfort (score 0) while two restorations (13.3%) exhibited a mild pain or discomfort (score 1).

This indicates that the postoperative sensitivity of restoration has remarkably decreased during the follow-up periods and almost totally disappeared after 7 weeks. During 3-day and 7-day follow-up periods of resin modified glass ionomer cement (RMGIC), 14 of the sample (93.3%) did not exhibit any sign of postoperative sensitivity (score 0) while one restoration (6.7%) showed mild pain or discomfort (score 1).

In 3-week follow-up period, 15 restorations of the sample (100%) did not exhibit any sign of pain or discomfort (score 0). During a 7-week follow-up period, 10 restorations of the sample (66.7%) did not show any sign of pain or discomfort (score 0) while 5 restorations of the sample (33.3%) expressed a mild pain or discomfort (score 1). This reveals a remarkably and statistically significant increase in the postoperative sensitivity of restoration especially in 7-day to 7-week and 3-week to 7-week follow-up periods to include almost the whole sample. This differs from what Dutra found in 2012. He stated a decrease in the postoperative sensitivity of the restoration as we proceed in follow-up periods on contrary to the results achieved in current study regarding RMGIC (PERDIGÃO 2012). In terms of differences between the study groups within different time periods, the study shows that:

After three days of restoration, no statistically significant difference was observed between EvoCeram and Beautifil II composites with results obtained using Beautifil II were slightly better. Beautifil II composite outperformed Compoglass F as a statistically significant difference exists in terms of postoperative sensitivity of restoration which goes along with Gupta's study conducted in 2011. The outperformance could be attributed to the fact that the adhesive system used with Beautifil II is self-etching which reduce the overdrying, and so less sensitivity after restoration (GUPTA 2011). It also agrees with Khalil's findings in 2011. He showed the outperformance of materials using self-etching adhesives over total-etching adhesives, particularly during the first few weeks of restoration (Khalil 2011).

This study differs with that conducted by Amin in 2015. He

revealed that restorations using total-etching adhesive system were less sensitive in comparison to those using self-etching adhesive system in the first days (Amin 2015) ^[6]. This difference could be attributed to that the total-etching adhesive systems help provide efficient and sufficient protection to the dental pulp and induce it to form tertiary dentin, leading to a decrease in postoperative sensitivity of restoration (al-Abboud 2017).

It also differs with Scientist Chen's conclusion in 2006. He revealed that the Nanohybrid composite has less polymerization shrinkage, and thus less postoperative sensitivity of restoration (CHEN 2006) ^[18]. A statistically significant difference was observed between EvoCeram and Compoglass F in favor of EvoCeram.

No statistically significant difference was observed neither between EvoCeram and RMGIC nor between Beautifil II and RMGIC. A clear increase in the postoperative sensitivity of Compoglass F restoration compared to the remaining study groups. This agrees with Priyadarashini's findings in 2017, stating that the postoperative sensitivity of restoration disappeared since the first day of applying restorations to 120 nonnecrotic cervical lesions in 20 patients (Priyadarshini 2017) ^[42]. After seven days of restoration, no statistically significant difference was observed between EvoCeram, Beautifil II and RMGIC while a significant increase in postoperative sensitivity of restorations using Compoglass F was reported in comparison to other groups in the study.

This agrees with Amin's study in terms of the disappearance of postoperative sensitivity of restoration after 7 days in both systems (Amin 2015) ^[6] as well as Choi's study in 2019. He indicated that RMGIC restorations exhibited less level of sensitivity in the first few days given that they chemically adhere to dental tissues and prevent the microleakage of fluids towards the restored surface (CHOI 2019) ^[19].

It also agrees with Affifi's study in 2019 which showed no statistically significant difference between restorations using self-etching adhesives and total-etching adhesive materials after one week of restoration, at the same time, it differs with it as the Afifi's study stated no difference whether restorations applied on one layer or multiple layers (AFIFI 2019).

After 3 weeks of restoration, no statistically significant difference was observed between the study groups in terms of postoperative sensitivity, except for Compoglass F which exhibited significant increase in the level of sensitivity.

This agrees with what Vaid found in 2015. He stated that there is no difference between RMGIC and Nanohybrid composite on teeth necrosis of 87 of the sample of nonnecrotic cervical necrosis during the first month after restoration. Seven weeks after restoration, no statistically significant difference was observed neither between EvoCeram and Beautifil II nor between RMGIC and Compoglass F in terms of postoperative sensitivity of restoration. Meanwhile, EvoCeram and Beautifil II outperformed over RMGIC and Compoglass F in terms of postoperative sensitivity of restoration. This agrees with the findings of Khalil in 2011 and Browning in 2007 ^[16] which indicted that there is no difference in materials using self-etching adhesives or total-etching adhesives in the long run regarding the situation of conservative restorations (Khalil 2011).

It is broadly compatible with Rusnac's referential study in 2019, Itota's study in 2005 and Cury's study in 2016 which revealed that the Beautifil II Giomer is similar to hybrid-particulate composite in terms of postoperative sensitivity of restoration, showing a decrease in the incidence of secondary

caries around Giomer restorations because of fluoride release (ITOTA 2005, CURY 2016).

The results are in line with Matis' study in 2004^[34]. Stating that there is no difference between Giomer and hybrid-particulate composite in terms of the postoperative sensitivity after three years of study (Matis 2004)^[34].

The conclusions of this study differ with Walia's findings in 2016 which showed that the RMGIC outperformed Beautifil II in terms of the higher rate of microleakage and thus the greater postoperative sensitivity would be. The difference may be attributable to the fact that Walia's study was conducted on Class V cavities taking into consideration the accompanying large microleakage and the chemical bonding strength of RMGIC (WALIA 2016)^[53].

They also differ from Yadaf's study in 2012 which showed the outperformance of Compomer and RMGIC over Giomer whose samples exhibited the highest microleakage scores between the study groups. This can be attributed to that the Compomer used in the study has chemical and optical polymerization provided in two separate containers and they are merged together upon mixing, as well as the Class I restorations studied by Yadaf have been applied to primary teeth, therefore the adhesion of Compoglass F and RMGIC is stronger (GUNJAN 2012)^[26]. This study disagrees with that conducted by Toledano in 1999^[63] which concluded that Compomer outperformed RMGIC in terms of marginal microleakage, and thus the occurrence of higher postoperative sensitivity of restoration that was clear in RMGIC samples (Toledano 1999)^[63]. The results of current study disagree with those of Brackett study in 2003 which showed no statistically significant difference between RMGIC and Z250 Nanohybrid composite after two-year follow-up period (Brackett 2003)^[65].

They also differ with Jyothi study in 2011^[29] which showed no statistically significant difference between RMGIC and Beautifil II in terms of postoperative sensitivity of restoration, and this sensitivity has disappeared in both restoration samples (Jyothi 2011)^[29]. The reduction in postoperative sensitivity of restoration in current study can be attributable to compliance with the instructions stated by the manufacturing companies of materials used in this research, in addition to the decrease in the polymerization shrinkage as well as the reduction in polymerization tensile forces of the all materials used. This agrees with study conducted by Sancakli and colleagues in 2014, revealing that the postoperative sensitivity of restoration depends on the practitioner's skill and expertise (SANCALKI 2014)^[44].

5. Conclusions

We can use Beautifil II and EvoCeram reducing the postoperative sensitivity specially in the first few weeks.

6. References

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