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COMPARISON BETWEEN MICRO HARDNESS OF THREE DIFFERENT TYPES OF GLASS IONOMER RESTORATIONS IN CLASS V IN PRIMARY TEETH: AN IN- VITRO STUDY

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KEYWORDS

ACTIVA bioactive restoration, EQUIA, Microhardness.

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ABSTRACT

Background: 60–90% of schoolchildren are exposed to dental caries in both developing and developed countries. Furthermore, among Middle-Eastern schoolchildren studies have shown that the prevalence of dental caries was up to 83.3% .and in Egyptian children and adolescents (3-18y) were examined over one year, 74% of them had dental caries**.** Glass ionomer can form general chemical bonds with tooth substrate and display adequate margin sealing. **Aim:** This study aimed to evaluate and compare The Micro hardness of Glass ionomer(FUJI I), Highly viscous glass ionomer (EQUIA)and Bioactive material restoration(ACTIVE) in class V cavity in primary molars. **Matrials and methods:** A Thirty six extracted primary upper second molars with prepared class V cavity fulfilling the inclusion criteria for microhardness test was divided in three groups according to types of restorative materials (FUJI I(I), EQUIA(II) and ACTIVA(III))So, n=12. **Results:** the statically analysis showed that the highest micro hardness were recorded in EQUIA (mean HV= 51.4 kg/mm^2) followed by ACTIVA (mean HV= 51.4 kg/mm^2) and the lowest microhardness were recorded in FUJI I (mean HV= 50.3 kg/mm^2). **Conclusion:** EQUIA (the high-viscous glass-ionomer restoration) has highest microhardness than other two restorations.

INTRODUCTION

According to World Health Organization reports, 60–90% of schoolchildren are exposed to dental caries in both developing and developed countries. Furthermore, among Middle-Eastern schoolchildren studies have shown that the prevalence of dental caries was up to 83.3% [(1)] and in Egyptian children and adolescents (3-18y) were examined over one year, 74% of them had dental caries [(2)].

Glass ionomer can form general chemical bonds with tooth substrate and display adequate margin sealing. However, they are not ideal material for class V cavity restorations due to highly resorption in oral cavity because its sensitive to moisture. Highly viscous glass ionomer cements HVGIC were presented to the market in 2007. The hardening mechanisms of these newly developed HVGIC are the same as conventional due to the dual mechanisms chemically as conventional and mechanically with light cure compared to conventional Glass ionomer restoration.

A new HVGIC restorative system (EQUIA; GC Europe, Tokyo, Japan) was introduced, which could be an alternative to composite resins in the posterior region, and was designed for the use in the permanent restoration of Class I, II and V cavities combining the advantages of HVGIC and a surface coating resins [3,4].

Recently, new bioactive materials are emerging adding beneficial properties over the existing restorative materials; it can react to the oral changes by means of ion exchange leading to long-term clinical benefits, It combines between the strength and esthetics of composite resins and the benefits of glass ionomers such as moisture tolerance, release and recharge of ions (F ions). ACTIVA material bond to the tooth structure chemically, to add benefits to the bond characteristics by providing seal against bacterial micro leakage [5]**.** Additionally, it reacts to pH changes in the mouth by uptaking calcium, phosphate, and fluoride ions to maintain the chemical integrity of the tooth structure [6].

Therefore, the aim of this study was to evaluate and compare the micro hardness of glass ionomer (FUJI I), highly viscous glass ionomer (EQUIA) and Bioactive material restoration (ACTIVA)in class V cavity in primary molars.

MATERIALS AND METHODS

The present study was conducted on unidentified 36 extracted maxillary second primary molars (collected from the Pediatric Dentistry Department, Faculty of Dentistry, Suez Canal University) after waved from the approval of research ethical committee (REC) of Faculty of Dentistry, Suez Canal University no. (243/2019).

The sample size calculation

The sample size for this study was calculated according to the following equation:

$$N = \frac{N = (Z\alpha)^2 \times (SD)^2}{d^2}$$

N = Total sample size, $Z_{\alpha =}$Is Standard normal variate and its equal 1.96 at P< 0.05, SD = Standard diversion of variable & d = Absolute error or precision A- Test one Total Sample size N = 35.971 ≈36 samples Total sample size is 36 Samples

$$\text{Total Sample size } N = \frac{(1.96)^2 \times (6.12)^2}{2^2}$$

= 35.971 ≈36 samples

Total sample size is 36 Samples

Study design

Micro hardness test:

Teeth selection:

Thirty six extracted primary molars (upper second molar) due to near shedding time, were selected for this study according to the following inclusion criteria [7,8]:

1. All selected primary molars had sound cervical area.
2. They were free from morphological anomalies in the crown.
3. They were free from cracks or fissures in the enamel surface.

Clinical procedure and teeth grouping;

Thirty six primary upper second molars were divided randomly by dice (below and equal 4 chosen for control group, over 4 and odd for EQUIA and even for ACTIVA) into three groups according to the type of the restoration that was used to restore class v cavity and each group consisted of 12 primary molar while (FUJI I) was considered as a control group, (EQUIA)and (ACTIVE) considered as a tested group.

Tissue fragments and debris were removed from all selected primary molars by scaling, and then teeth were disinfected in 5.25% sodium hypochlorite for 30 mins[9] and stored in distilled water until use. Each tooth was embedded into an acrylic block at the cemento-enamel junction.Class v cavity preparation was done in the buccal surface of each molar using high speed handpiece**.** The prepared class v cavity had standardized dimensions**:** Height :2mm occlouso- gingivally,width: 3mm mesio-distally and depth: 1.5mm [10,11,12] in middle third of each buccal surfaces of all molar.The cavities were standardized using a transparent matrix band into which a window representing the required dimensions was cut into its middle, The dimensions of a box shape were measured with graduated periodontal probe[11] **(Figure 1 and Figure 2).**

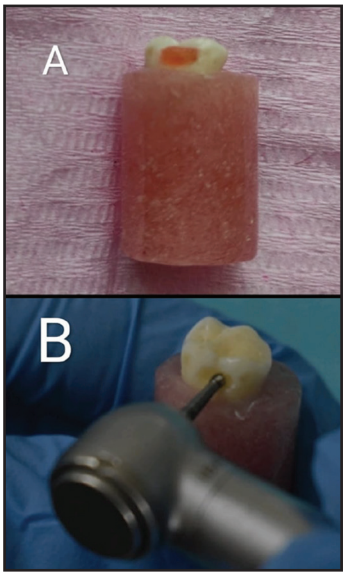

Fig. (1) (A) Demarcation of cavity dimensions using a color marker and (b) Cavity preparation by round bur.

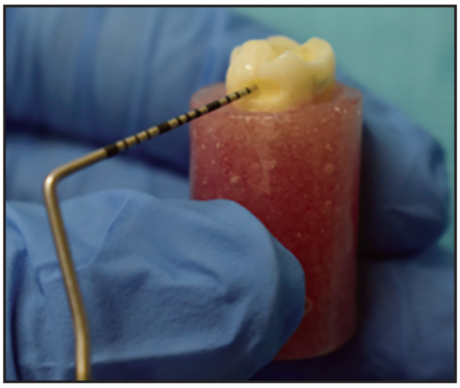

Fig. (2) Class V cavity preparation with standardized dimensions

Restoration procedures:

All cavities were restored by each restorative materials according to the manufacturer's instructions (**Figure 3**). For (FUJI I) the capsule pushed at button, then putted in amalgamator device for 10 counts, then fill the cavity by restoration, finally cure the FUJI I for 20sec**.** For (EQUIA) the capsule pushed at button, then putted in amalgamator device for 10 counts, then fill the cavity by restoration, finally put a EQUIA coat then cure for 20sec. For (ACTIVA), etch the cavity by etching for 10 sec, then rinse the cavities, dry cavity by air, fil the cavites, finally cure for 20sec. The restored molars were subsequently polished using flexible plastic coated discs.

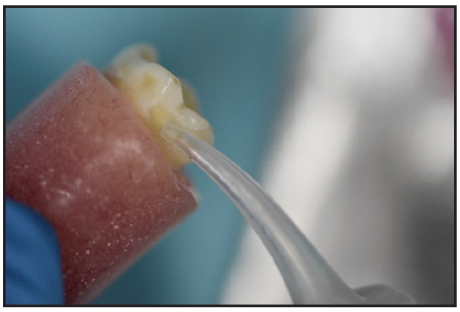

Fig. (3) Cavity restored with three different restoration.

After polishing, the teeth were stored in an incubator for 24 hrs in distilled water at 37˚C [13]. All restored samples were thermocycled for 10,000 at temperature range 5–55°C to simulate one year aging period, by Cycling Dwell time 25 seconds and transfer time between cycles 10 seconds [14].

Cutting the sample:

All thermocycled restored molars were cut mesiodistally using aluminum disc by lowspeed hand piece with coolant system to obtain two halves (**Figure 4**), each buccal half was fixed on anther acrylic block which introduced class v facing upward for micro hardness examination**.**

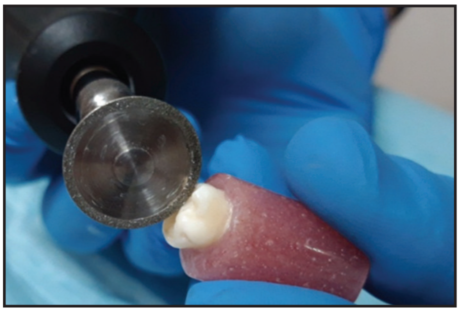

Fig. (4) Cutting samples.

Evaluation method for micro hardness:

Vickers testing for micro-hardness:

Microhardness of each specimen's was determined by using a Vickers diamond indenter **(Figure 5)**. (Isoscan HV2, LTF Spa, Antegnate, Bergamo, Italy), measurement of micro hardness was performed in Dental Material Department, Faculty of Dentistry, AL-Azher University.

Measurements were accomplished with 50 g at depths of 0.4mm,1 mm, 1.5mm on the upper surface of each specimen [15], in which magnification by microscope was 40x ,while magnification amount in (**Figure 6)** was100x.

In this method, a square-based pyramid diamond indenter with an open face angle of 136° was impressed vertically onto the surface of the test specimen [15,16].

Measuring coordinates were set to cover the entire surface area of a specimen restoration in the middle of all specimens occluso -gingivaly (**Figure 5,6**).

In each sample, three indentations equally spaced over a circle and not closer than 1 mm to the each other, the margin of each indention specimen were taken at the all-predetermined depths and then the average (micro hardness mean value) was calculated.

A micro-hardness mean value for each tested material was determined at the specified depths of materials (**Figure 6**).

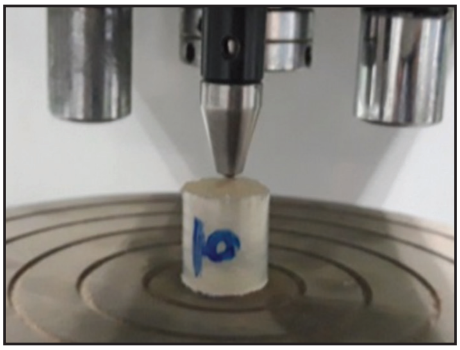

Fig. (5) Vicker's diamond indenter

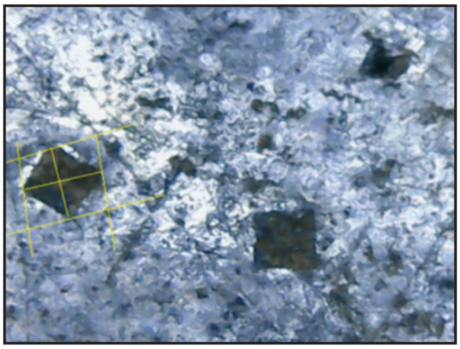

Fig. (6) Measuring the entire surface area of indentations with magnification amount 100x (fig7)was100x..

Statistical analysis

Data represented as mean and standard deviation. Differences assessed by paired samples t-test, one-way ANOVA, and Multivariate analysis of variance. Means followed by different letters vertically are significantly different according to Tukey's HSD at 0.05 level.

RESULTS

The micro hardness in **(FUJI I)** ranged between 46.2 to 52.2 with mean of 50.3±1.7, while in **(EQUIA)** ranged between 49.8 to 52.6 with mean of 51.5 ± 0.7, However, **(ACTIVA)** ranged between 48.1 to 53.1 with mean of 51.4 ± 1.4 (Table 1). The highest micro hardness was recorded in **(EQUIA)** (mean HV= 51.5 kg/mm^2) restored cavities followed by **(ACTIVA)** (mean HV= 51.4 kg/mm^2) and the lowest microhardness were recorded in **(FUJI I)** (mean HV= 50.3 kg/mm^2). When comparing the three treated groups using one way ANOVA; there was highly significant difference in micro hardness between three restorations **(FUJI I, EQUIA, and ACTIVA)** in Class V restored cavities in primary molars *p<0.01*.

Both **(EQUIA)** and **(ACTIVA)** showed the highest microhardness among tested materials (51.5-51.4 kg/mm^2) respectively. When comparing between **(EQUIA)**and **(ACTIVA)**; there was nonstatistical significant difference between them. As revealed by ANOVA followed by different letters are significantly different according to Tukey's HSD at 0.05 level (**Table 1**), (**Figure 7**).

Table (1) *Correlation of micro hardness mean ± SD of three different types of restorative materials*

HV	Mean	SD	SE	CI (95%)		Minimum	Maximum
				Lower	Upper		
FUJI1	50.3b	1.7	0.4	49.4	51.1	46.2	52.2
EQUIA	51.5a	0.7	0.2	51.2	51.9	49.8	52.6
ACTIVA	51.4a	1.4	0.3	50.7	52.1	48.1	53.1
p-value	0.010**						

CI: confidence intervals for mean

NS; non-significant at p>0.05

, **, ** significantly different at p<0.05*, 0.01, 0.001***

While (a, b and c) are post ANOVA analysis:

(a) =maximum value

(b) = middle value

Means followed by similar litter are non-significant different in same column.

SD: significant difference.

SE: stander error

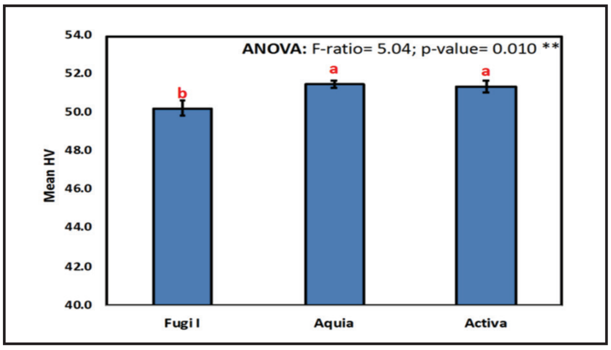

Fig. (7) Bar chart representing micro hardness mean of three different **restorative materials (FUJII, EQUIA, and ACTIVA) in Class V. in primary molars.**

DISCUSSION

Glass ionomer cements have specific properties such as fluoride ion release and recharging ability, biocompatibility ,the ability to bulk fill of the cavity and adhesion to tooth structure as esthetic restoration in primary dentition and in low stress bearing area ,the demand for use this materials in high stress area lead to development a new materials to improve the strength and biological properties such as **FUJI**, **EQUIA** and **ACTIVA**[17].

In current study, the selected primary molars were extracted for near their time of shedding [10]. The extracted primary molars had sound enamel surfaces (structure and morphology) [7,8,10], In order not to affect the result during cavity preparation and avoid any problem which can appear if carious tooth or cracked one are used. All the tissue fragments and debris were removed from all selected primary molars by scaling, and they were disinfected in 5.25%sodium hypochlorite for 30 minutes, while this concentration not affect the hardness of molars and stored in distilled water to prevent bacterial growth until used for microhardness testing[9].

During preparation of the cavities, the diamond bur changed every four cavities, this in agreement with **Emir *et al.,*** [18] and **Talat** [12] because diamond burs exhibit wear with repeated use in clinic. This wearing appears as a reduction in surface roughness of the bur and thus the reduction in their cutting efficiency [12,19].

FUJI was used in primary molars as conventional glass ionomer cements to restore class V cavity as it has many advantage properties such as direct chemical bonding to tooth structure and less pulpal irritation due to good biocompatibility [19].

In the present study, **EQUIA** was used to restore class v in primary teeth in accordance to **Ali *et al,*** [13] as EQUIA has micron sized Fluor aluminosilicate fillers to the conventional one. The addition of these highly reactive fillers leads to release more fluoride and metal ions and improves the physical properties of the set material reinforced with ultrafine and reactive glass particles forming a glass hybrid restorative system.

In addition, **ACTIVA** was selected in the present study as it a new bioactive restoration that mimics the physical and chemical properties of the teeth [5]. After restoration of all prepared cavities with the different restorative martials according to manufacture instructions, Finishing and polishing of restorative surfaces was done [20].

In the current study, the results revealed that the (group II)**EQUIA** and (group III)**ACTIVA** have a highest microhardeness values , these results was in agreement with **Peutzfldt *et al,*** [21] and **Garcia *et al,*** [22].

Moreover, **Ozan *et al,*** [23] who studied different types of glass ionemer, compomer and composite found that the high-viscous glass-ionomer cements **(EQUIA)** has enhanced mechanical properties than GICs.

Limitation

Collection of extracted molars with the inclusion criteria was very difficult.

CONCLUSIONS

On the basis of this study, it can be concluded that:

- EQUIA restoration had the highest micro hardness followed by ACTIVA BIOACTIVE Restoration.
- FUJI restoration had the least micro hardness. so, not advice to be used as final restoration.

RECOMMENDATIONS

1. Highly viscous glass ionemer (HIGVI) can be used as promising restorative material due to high surface micro hardness.
2. This study did not analyze a biological effect of Activa, Equia and FujI I.

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