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Comparative Measurement of Immediate Fluoride Release by Three Bioactive Restorative Materials: An In Vitro Study.

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ABSTRACT: The aim of this study is to compare the immediate fluoride release of three bioactive restorative materials, self-adhesive hybrid composite, bioactive flowable composite liner and alkasite restorative material. Twenty-two discs were fabricated from each selected material. Each disc was placed in 5mL deionized water and fluoride release was measured after 24h. Fluoride release from self-adhesive hybrid composite was statistically significantly higher than Alkasite restorative material and bioactive flowable composite respectively. In conclusion, the three bioactive restorations exhibited fluoride release. Self-adhesive hybrid composite showed the highest fluoride release after 24 hours and bioactive flowable composite showed the least amount of fluoride released.

KEYWORDS: Bioactive Materials, Fluoride, Alkasite Restorative Materials.

I. INTRODUCTION

[1]Bioactive materials were developed to overcome the limitations of conventional restorative materials. Conventional resin composite restorations often face challenges, particularly in the gingival area, due to the insufficient enamel thickness available for proper bonding and because of shrinkage during the polymerization process. Another contributing factor to their shortcomings is their inability to raise the local pH, which means they cannot prevent the formation of secondary caries.

[2]While conventional glass-ionomer cement (GIC) has the advantage of releasing fluoride, its limited strength restricts its use in areas subjected to stress. [3]On the other hand, bioactive restorative materials enhance the presence of fluoride in saliva, plaque, and hard dental tissues while releasing an appropriate amount of fluoride into the oral environment. [4]These restorative materials possess properties that assist in remineralization. They are placed directly in contact with the remaining dental tissues to facilitate the healing process of dental tissues, thereby preventing the occurrence of secondary caries.

II. MATERIALS AND METHODS

The materials employed in this investigation encompassed three distinct bioactive materials: Self-adhesive hybrid composite (Surefil One, Dentsply Sirona), Bioactive flowable composite (Re-Gen Flowable Composite, Vista Apex), and Alkasite restorative material (Cention Forte, IvoclarVivadent). The details of these materials, including their manufacturers, types, compositions, and batch numbers, are listed in table 1.

Sixty-six disc-shaped specimens were fabricated, each measuring 2mm in thickness and 10mm in diameter. These specimens were prepared for each of the selected materials (Surefil One, Re-Gen Flowable Composite, and Cention Forte).

[5]To create the discs, molds were employed, placed on a mylar strip based by a glass slab. An additional mylar strip and glass slab were then applied on the top of the restoration within the mold, to apply pressure and eliminate excess material. In total, 22 discs were produced for each material.

[6]Each disc was placed within an individual container containing 5mL of deionized water, devoid of any minerals, prepared in the Faculty of Agriculture at Mansoura University. These containers were stored at 37°C in an incubator (Imperial II Incubator, Lab Line Instruments, Inc.) for 24 hours. After this 24-hour

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period, the water in each container was agitated and removed for examination.

Table 1: Materials used in the current study.

Material	Manufacturer	Type	Composition	Batch Number
Surefil One	Dentsply, Konstanz, Germany	Dual-curing, Self-adhesive composite hybrid	MOPOS, BADEP, acrylic acid, water, reactive glass filler, non-reactive glass filler, initiator, stabilizer.	2104000853
Re-Gen Flowable Composite	Vista Apex, USA	Light-curing, Flowable composite liner	Barium glass, 2-Propenoic acid, 2-methyl-, (1-methylethylidene) bis[4,1-phenyleneoxy(2-hydroxy-3,1-propanediyl)] ester, TEGDMA, Submicron Silica, Benzoic acid, DMAEE.	90648
Cention Forte	IvoclarVivadent, Liechtenstein	Self-curing Alkasite restorative material	UDMA, initiator, glass filler, pigments.	740832WW
Abbreviations: MOPOS: Modified polyacids, BADEP: Bifunctional acrylate,TEGDMA: Triethylene glycol dimethacrylate, DMAEE: 4-(dimethylamino)-, ethyl ester, UDMA:Urethane Di methacrylate.				

The concentration of fluoride ions was determined using the SPADNS colorimetric analysis method. This method relies on the reaction between fluoride and a zirconium-dye lake. Fluoride reacts with the dye lake, causing a portion of it to dissociate into a colorless complex anion (ZrF6 -2) and the dye. As the fluoride concentration increases, the resulting color becomes progressively lighter.

III. RESULTS

Data collected was tabulated and analyzed by statistical package for social science (SPSS) version 25 (Armonk, NY: IBM Corp) on an IBM-compatible computer.

One-way ANOVA test followed by post hoc test (LSD) was used for comparison between the fluoride test results in the three groups after 24 hours and showed that fluoride test results in group A were statistically significantly higher than groups B and C. Regarding group B, results were statistically significantly lower than group C (table 2).

Table 2:Comparison between three groups as regards fluoride test results after 24 hours.

Group	**A (Self-adhesive hybrid composite)**			**B (Bioactive flowable composite liner)**			**C (Alkasite restorative material)**			**P-value**
	Min	**-**	**Max**	**Min**	**-**	**Max**	**Min**	**-**	**Max**	
	Mean	**±**	**S. D**	**Mean**	**±**	**S. D**	**Mean**	**±**	**S. D**	
After 24 h	24.920	-	60.650	1.090	-	14.070	5.480	-	17.410	P1=<0.001* P2=<0.001* P3=0.027*
	41.836	±	10.536	5.822	±	4.460	10.548	±	3.618	

P1: Group A vs Group B, **P2:** Group A vs Group C, **P3:** Group B vs Group C

IV. DISCUSSION

[9]These innovations aim to achieve a dual purpose: the preservation of dental tissues and the effective prevention of caries while promoting remineralization.[10]Fluoride's role in reducing dental caries has been recognized since the 1930s.

[11]It enhances tooth resistance to cavities through a range of protective mechanisms encompassing both biological and physicochemical

aspects. From a biological standpoint, fluoride can disrupt the formation of pellicle and plaque. It also exerts an influence on the metabolic activity of cariogenic bacteria, inhibiting their ability to secrete enzymes that ferment carbohydrates and, consequently, reducing acid production. Additionally, fluoride contributes to the inhibition of microbial growth.

[12, 13] In the current study, deionized water was selected as the medium for fluoride release measurements due to its accessibility and it is easily prepared.

[14]The SPADNS colorimetric method was employed for fluoride release measurement due to its simplicity and availability.

[15]A notable initial release of fluoride release may have contributed to the significant fluoride liberation observed from the Self-adhesive hybrid composite group after 24 hours. The findings of this study indicate that Alkasite restorative material exhibited lower fluoride release compared to the self-adhesive composite, possibly due to the absence of an initial liberation effect.

[16]This observation aligns with a study that reported higher fluoride emission from GICs compared to Alkasite restorative material throughout all measurement intervals.

The Bioactive Flowable Composite may have shown the lowest fluoride release due to the absence of an initial fluoride burst. Additionally, unlike Alkasite restorative material, it lacks alkaline fillers, which may contribute to the least fluoride release.

V. CONCLUSION

Within the limitations of this in vitro study, it could be concluded that:

- The Self-adhesive hybrid composite was the material with the highest fluoride released after 24 hours.
- Alkastite restorative material showed less amount of fluoride released than self-adhesive hybrid composite, but more than bioactive flowable composite liner.
- The bioactive flowable composite liner showed the least amount of fluoride released.

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