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RESEARCH ARTICLE

SPECTROPHOTOMETRIC EVALUATION OF MICROLEAKAGE IN CLASS V CAVITY USING NEW GLASS IONOMER CEMENTS: AN *IN VITRO* STUDY.

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Abstract

Objective: The aim of this study was to quantify the marginal leakage of two glass-ionomer cements using spectrophotometer. **Method and materials:** Standardized class V cavities were prepared on 60 extracted human maxillary permanent first premolars, randomly assigned to two groups of 30 teeth each, group A and group B. Group A was restored with Zirconomer and group B was restored with GC Fuji IX Extra. Teeth were subjected to thermocycling and stained with methylene blue. The microleakage was quantified spectrophotometrically and the data were statistically analyzed with Student t test. **Results:** Restorations of both the materials showed some microeakage in Class V cavities and there were no significant differences statistically. **Conclusion:** The sealing ability of GC Fuji IX Extra was much better than Zirconomer and GC Fuji IX Extra exhibit better shade matching compared to Zirconomer at cervical area of the teeth.

Introduction:-

Microleakage is the most common cause of failure of almost all restorative materials since it is a major contributing factor to secondary caries and pulpal irritation[1]. Accordingly, there is an interest in finding a restorative material which has better bond characteristics, thus minimizing microleakage and reducing the potential for caries development at the tooth surface interface and resultant pulpal irritation[2].

Glass ionomer cements[3,4,5] are indicated for dentin Class V cavities because their properties include chemical adhesion to tooth structure[6,7], anticariogenic effect resulting from fluoride release[8], thermal compatibility with enamel and dentin, and low setting shrinkage[9]. However, glass ionomer cements have well-known weaknesses, lack of strength, susceptibility to moisture and dehydration, and technique sensitivity and poor esthetics [9,10].

To improve the physical properties and clinical handling characteristics of glass ionomer cements, zirconia reinforced glass ionomer cement (Zirconomer) has been introduced. The influence of formulation changes on marginal sealing ability should be investigated for this glass ionomer cements.

The purpose of this in vitro study was to quantify and compare the marginal leakage of two glass-ionomer cements – Zirconia reinforced GIC (Zirconomer) and conventional GIC (GC Fuji IX Extra).

Method and materials:-

Sample preparation:-

Sixty extracted human permanent maxillary premolar teeth, free of visible caries, cracks, and restorations, were used in this study. The teeth were cleaned and stored in distilled water at room temperature to prevent dehydration. A standardized Class V cavity preparation was done on facial surface of each tooth using tapered fissure carbide bur (No.271 ,SSC White, Lakewood, New Jersey) in a high-speed handpiece (air rotor NSK, Japan) with water coolant. The bur was replaced after every four preparations. The dimensions of the cavities were 1.5mm depth, 1.5mm width and 1.5mm length (Figure 1). A William's graduated periodontal probe (Hu-friedy, Chicago, IL, USA) was used to gauge the dimensions of the cavity. Teeth were randomly divided into two groups namely group A and group B. Each group comprises thirty teeth each. Before restoration, all cavities were sprayed with water to loosen all debris left from preparation and dried with air to prevent dehydration of dentin. Group A restored with zirconia reinforced GIC (Zirconomer) and group B restored with GC Fuji IX Extra following manufacture's recommendations.

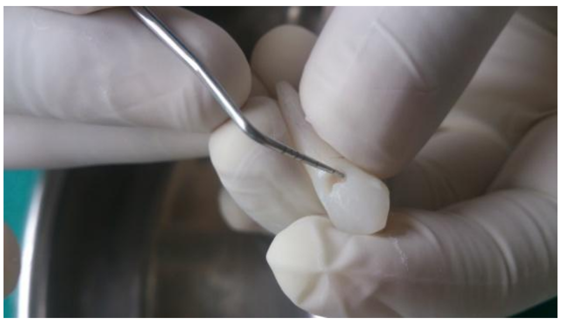

Figure1: class V cavity preparation on buccal surface of maxillary first premolar teeth.

The restoration surfaces were immediately protected with varnish. A mylar strip matrix was placed over the restoration and held in position for 5 minutes. Seven minutes after the beginning of the mixture, the matrix was removed and the surface protector was immediately applied. The restored teeth were stored in distilled water at room temperature for 24 hours. Restorations were finished wet with a graded series of aluminum oxide disks (Sof-Lex, 3M ESPE, St Paul USA). They were then stored in distilled water at room temperature for 24 hours before thermocycling.

Thermocycling regimen and dye penetration:-

All external surfaces of each tooth were coated with two layers of varnish, leaving a 1.5 mm wide margin around the restoration free of varnish. During the process of sealing the specimens, the restoration surfaces were protected with disks of adhesive tape to prevent desiccation. The teeth were placed into separate mesh bags and thermocycled for 500^0C cycles in water bath between 5°C ± 2°C and 55°C ± 2^oC with a dwell time of 30 seconds at each bath and a 15-second transfer time between baths.

After cycling, the coronal surfaces of the teeth were placed in a 0.5% methylene blue solution at room temperature for 24 hours (Figure 2). The teeth were then rinsed, and the varnish was removed with a blade. The restorations were dry polished with Sof-Lex disks to remove superficial dye.

Figure 2: Coronal surfaces of the teeth were immersed in 0.5% methylene blue

Microleakage quantification:-

Microleakage was determined quantitatively by a method developed by Douglas and Zakariasen[11] and adapted by Rigsby[12] et al. Teeth were individually immersed in glass tubes containing 2 ml of 65% nitric acid (Figure3). Standard solutions of methylene blue in 2 ml of nitric acid were prepared containing from 0 to 10μg dye/ml.

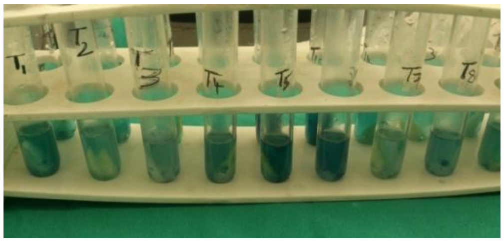

Figure3: Teeth were immersed in 65% nitric acid solution

After 48 hours, the teeth were completely dissolved (Figure 4). The standard and experimental nitric acid solutions were diluted with 1ml of distilled water. The solutions were centrifuged (4000 rpm, Cooling centrifuge, REMI) (Figure 5) and the supernatant (Figure 6) was used to assess the volumetric microleakage using spectrophotometer (UV 1800, UV Spectrophotometer, SHIMADZU).

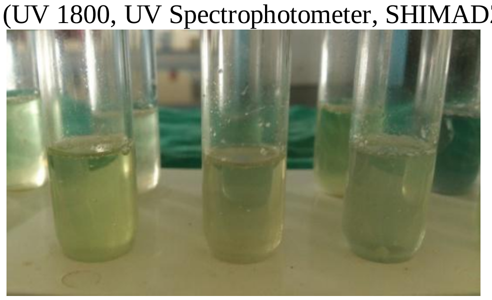

Figure 4: After 48 hrs, teeth were completely dissolved in 65% nitric acid solution

Figure 5: Solutions were centrifuged at 4000rpm

Figure 6: supernatant were taken in separate tubes.

The absorbance of the standard solutions containing 0µg/ml and 6µg/ml was determined at wavelengths ranging from 400 to 700 nm, and the maximum value was obtained at 598 nm (Figure7). Prior to determination of the absorbance of experimental solutions at 598 nm, the coefficient of correlation *(r)* between dye concentration and absorbance of standard solutions was calculated.

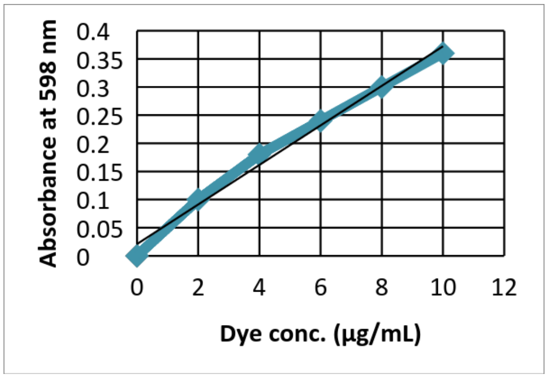

Figure7: Absorbance of standard solution with 0µg/ml - 10µg/ml dye concentration

To estimate the dye concentration of the experimental solutions, a linear regression was obtained and generically expressed as:

$$y=0.035x+0.021$$

Where *y* is the absorbance and *x* is the dye concentration. Marginal leakage was recorded as µg/ml.

Statistical analysis

The data were analyzed by nonparametric student t test to identify if there was any statistical significant difference between these two materials. Significance was considered at the ≤ 0.05level.

Result

Student t test showed no statistically significant differences in dye leakage between the restorative materials for gingival margins (P = 0.65)

Volumetric microleakage of Zirconomer & GC Fuji IX Extra

Group	Restorative Material	Mean	Median
1	Zirconomer	0.98	0.84
2	GC Fuji IX Extra	0.89	0.77

Discussion

Cervical lesions due to caries, erosion, or abrasion present a special challenge to any restorative dentist because in such cavities, the restorative material is usually required to adhere to different types of tooth tissues. The coronal margins of cervical restorations are usually in enamel, while the cervical margins are in dentin or cementum[13]. The occlusal stress generated in the cervical region during normal function and parafunction may increase microleakage or deteriorate the margins of Class V restorations[14].

Microleakage is the movement of bacteria, fluids, molecules, or ions, and even air between the prepared cavity walls and the subsequently applied restorative materials. Glass ionomers are alternative materials to composites for the cervical lesions because of their chemical adhesion to tooth structure, fluoride release, biocompatibility, lower shrinkage values, reduced microleakage, and acceptable esthetics[13]. However, they are susceptible to fracture and exhibit low wear resistance[15].

To overcome the disadvantages of low tensile strength and brittleness of glass ionomer, metal reinforced materials like Miracle Mix and Ketac Silver[16] were introduced. A disadvantage of metal reinforced cement however, is that they are not tooth colored. Recently, a new material, Zirconomer (Zirconia reinforced glass ionomer cement) has been introduced to combat these disadvantages. It is known to exhibit the strength and durability of amalgam with the protective benefits of glass ionomer, while completely eliminating the hazards of mercury. This high strength restorative has been specially reinforced with ceramic & zirconia fillers that impart remarkable mechanical properties. Combination of outstanding strength, durability and sustained fluoride protection deems it ideal for permanent restoration in patients with high caries incidence as well as cases where strong structural cores and bases are essential.

GC Fuji IX GP Extra is the fastest setting glass ionomer on the market. While maintaining the ample working time of GC Fuji IX GP Fast (1 1/4 minutes), GC Fuji IX GP Extra allows final finishing in only 2 1/2 minutes from initial mix. The faster final set saves valuable chair time which provides improved stability against water, an important feature in challenging oral environments. This product contains glass filler known as Smart Glass. The filler elicits higher translucency, fluoride release, reactivity and a faster setting time. The increased translucency allowed this product to be used in the anterior region with aesthetic results. *GC Fuji IX GP Extra is* especially useful for cervical restorations, where the high fluoride release is important.

The results of this study indicated that the microleakage of zirconia reinforced glass ionomer was slightly higher than that of conventional glass ionomer cement. Fuji IX Extra GIC showed better handling characteristics and shade matching compared to zirconia reinforced GIC. This may be due to the filler particle present in the GC Fuji IX Extra.

Microleakage is determined today by many *in vitro* techniques with or without thermal cycling, such as staining, scanning electron microscope, bacterial activity, decay, air pressure, chemical agents, markers, neutron activation analysis, radioisotope, ionization, autoradiography and reversible radioactive adsorption[17]. In this study, the dye leakage method was used because it is a simple, inexpensive, fast technique and does not require the use of complex laboratory equipments[13]. Dye leakage studies are amongst the most commonly used methods for detecting microleakage[18].

Various studies performed show that the dye leakages in different sections taken at different places of the restorations may show significant differences[19]. The spectrophotometric dye recovery method used in this study allows for the direct and quantitative measurement of leakage volumetrically[20, 21].

Teeth were selected in a random sequence, so that the variability arising from known sources of bias can be systematically controlled[21]. In this study, thermocycling was done because it is a widely used method in dental research to simulate temperature changes that take place in the oral environment[14, 22].

In fact, in the studies of dye penetration, the dentin staining was observed to be more different than the actual gaps between cavity walls and restoration materials. This resulted in the use of a dye with a particle diameter equal to the bacterial size or smaller by researchers. In this study, 0.5% solution of the methylene blue molecule was used since the particle size is less than that of the bacterial one. Methylene blue molecules were used because it also dissolve as monomer and bimer in an aqueous environment in which the pH is adjusted to 6.98 with a phosphate and biphosphate buffer[17].

In this study, there was no statistically significant difference in the microleakage of groups A and group B at gingival margins. However group A showed slightly higher level of dye penetration compared to group B.

Conclusion

Within the limitations of this study, it was concluded that none of the GIC were free from microleakage. The degree of microleakage was more with Zirconia reinforced glass ionomer cement (Zirconomer) than conventional glass ionomer cement (GC Fuji IX Extra). However there were no statistically significant differences between these restorative materials at gingival margins.

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