COMPARATIVE EVALUATION OF MICROLEAKAGE OF THREE COMMERCIALLY AVAILABLE RESTORATIVE GLASS IONOMER CEMENTS: AN IN VITRO STUDY.

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ABSTRACT

Aim: The aim of the study is to determine and compare the microleakage and marginal adaptation of three different glass ionomer cements in class v cavity using scanning electron microscopy analysis.

Materials and methods: In class V cavities, three distinct glass ionomer cements were evaluated for marginal adaptability in vitro. Groups 1 through 4 include Fuji Ix (Control), Zirconomer Improved, Riva Self Cure, and Xtracem-S. In this investigation, 40 recently extracted single-rooted human mandibular premolars were employed. Class V cavity measuring 3 mm broad mesio-distally, 2 mm wide occluso-gingivally, and 1.5 mm deep was constructed on the buccal and lingual sides of each tooth. The chosen samples were prepared with class V cavities repaired and randomly assigned to four groups of ten teeth each. The reconstructed teeth underwent thermocycling, and the restoration's center was longitudinally sectioned in a bucco-lingual orientation. After that, these sections were inspected at a 1000x magnification using a scanning electron microscope.

Results: Values from the marginal gap measurement were tallied and subjected to statistical analysis. Out of the four glass ionomer cements, Xtracem-S (GROUP 4) demonstrated the least microleakage at the significant level ($p<0.01$), followed by Fuji IX (GROUP 1), Riva self-cure (GROUP 3), and Zirconomer improved (GROUP 2). Fuji IX had the highest microleakage (CONTROL GROUP). Conclusion: Riva self-cure (GROUP 3) and Xtracem-S (GROUP 4) demonstrated comparatively less microleakage in this investigation. Zirconomer Improved (GROUP 2) and Fuji IX (GROUP 1) had the highest comparable microleakage.

Keywords: GIC, Zirconomer Improved, Microleakage.

Introduction:

The fundamental goal of the restorative material is to restore the healthy tooth structure's biological, functional, and aesthetic qualities. Any restorative dentist faces unique challenges when dealing with cervical lesions caused by caries, erosion, or abrasion because distinct tooth tissues require restorative material to attach to. Because of their chemical adherence to tooth structure, fluoride release's anticariogenic impact, thermal compatibility with enamel and dentin, and low setting shrinkage, glass ionomer cements are recommended for Class V cavities. The foundational research on zinc polycarboxylate cements carried out at the Government Chemist Laboratory in London in the early 1960s served as the basis for glass ionomer cements (GIC). [1]

DeTrey's ASPA, which was first made commercially available in 1975, was a copolymer of acrylic and itaconic acid and a newly synthesized high-fluoride glass powder. It was shown to be permanently stable in a 50% aqueous solution. Glass-ionomer cement is long-lasting and has a variety of beneficial clinical features. Crucially, GICs stick to moist tooth structure and produce fluoride for an extended length of time, preventing tooth decay from happening again. These qualities make these materials popular and attractive, along with their biocompatibility and acceptable aesthetics.[2,3]

However, due to their weak mechanical qualities and moisture sensitivity, glass-ionomer dental cements cannot be used in more clinical settings. To overcome these constraints, a great deal of work has been done on the chemistry of the basic glasses and acidic polymers as well as the cement formulation. A variety of nonreactive fillers, including metals, fibers, resins, and bioactive ion glass, have been studied in an effort to enhance the mechanical qualities of GICs without sacrificing their handling or biological qualities. Most of the time, it has been difficult to attach the reinforcing ingredient to the cement matrix. For the purpose of repairing stress-bearing regions, Fuji IX (GC Corporation, Tokyo, Japan) was introduced as a solution to the strength and wear resistance issues associated with traditional glass ionomer cements. This is a conventional GIC with strontium glass that strengthens the surface by allowing calcium ions to diffuse into the glass ionomer surface when it is placed in a calcium-containing environment, such as saliva. It plays a major role in the atraumatic restorative treatment (ART) approach.[4] Recently, a new class of restorative glass ionomer called ZIRCONOMER IMPROVED (Shofu Inc., Japan) has emerged. It is a revolutionary nano-sized zirconium dioxide filler reinforced material that combines the strength and durability of amalgam. White Amalgam is the name of it.[5,6]

A newer restorative glass ionomer without resin that eliminates the risk of volumetric shrinkage is called RIVA SELF CURE (SDI, Australia). It is free of bisphenol-A and HEMA. Another newer glass ionomer is called XTRACEM-S (Medicept Dental, UK), and it is reinforced with silver to improve mechanical properties and have antibacterial activity to prevent secondary/recurrent caries. There aren't many in vitro studies available to assess the qualities of the restorative materials mentioned above. These materials were therefore selected for experimentation. To assess the properties of restorative materials, including microleakage, bond strength, fluoride release, longevity, etc., in vitro experiments have been carried out. Preventing microleakage is one of the most crucial conditions for a successful repair, and this is accomplished by properly adhering the restorative material to the cavity walls.[7]

The failure of the restorative materials to achieve the full marginal seal results in micro fissures, which allow ions, liquids, and bacteria to seep in and cause pulpal infections, secondary decay, and sensitivity. Thermocycling is a restorative material study methodology that involves periodically exposing materials to hot and cold temperatures54. This simulates in vivo ageing of the materials. The margins of restorations allowing the active passage of ions and molecules have been demonstrated using numerous methods4. These methods make use of chemical tracers, compressed gas, microbes, scanning microscopy, and—possibly most importantly—dye penetration experiments. Due to its capacity to directly visualize marginal gaps and measure them—especially when contrasted to findings from other leakage studies - the scanning electron microscope's availability in dental research has significant implications for the study of marginal adaptation.[8,9] Therefore, the goal of the current investigation is to assess, using scanning electron microscopic examination following thermocycling, the microleakage of various glass-ionomer restorations put in Class V cavities.

Material and Method: In this investigation, sixty human premolars that had been removed for periodontal or orthodontic purposes were employed. Each tooth's buccal and lingual surfaces had a standardized Class V cavity produced using an SF 11 bur in a high-speed handpiece with water cooling. Following each of the four preparations, the bur was changed. Selected samples randomly divided in to four groups of 15 teeth each. Experimental restorative materials manipulated according to manufacturer's Recommendation and prepared class v cavities restored. GROUP 1- Class V Cavity Restored with Fuji IX (n=15) GROUP-2- Class V Cavity Restored with Zirconomer Improved (n=15) GROUP-3 – Class V Cavity Restored with Riva Self Cure (n=15) GROUP-4- Class V Cavity Restored with Xtracem-S (n=15). All materials were manipulated as per manufactured instructions and restored in cavity.

The restored teeth were kept for a week at 37°C in distilled water. The recovered teeth were thermocyclically treated for 1000 cycles in a water bath at 5 and 55 degrees centigrade after one week. A thermometer was used to measure the temperature. Over the course of a day, the thermocycling regimen was spread out equally. After that, they were kept for a week at 37°C in distilled water. Using a water-cooled, low-speed diamond disc, the samples were sectioned longitudinally in a buccolingual direction across the restoration's center.

Prior to SEM analysis, the teeth were thoroughly dried by exposing them to the elements for a day and then heating them gently for 30 minutes to eliminate any residual moisture. These sections were sputter coated with gold-palladium, mounted on aluminium stubs with silver paint, and seen under a scanning electron microscope with a 15 Kv acceleration voltage. A a thousand times magnification was used to obtain micrographs of the marginal gaps in order to standardize the microscopic findings. All specimens' marginal gaps in the gingival and occlusal edges were measured in microns. After tabulating the data, statistical analysis was performed.

Result

Statistical analysis revealed insignificant differences at the occlusal and the gingival margins (Intra group comparison). However, the difference was significant among the four groups (Inter group comparison). There were insignificant differences between groups 1 and 2, 3 and 4. At occlusal margins, the order of microleakage score was Group 4< Group 3< Group2< Group1. At gingival margins, the order of microleakage score was Group 4< Group 3< Group2< Group 1. Xtracem-s (GROUP 4) showed least microleakage among the four glass ionomer cements at the significant level.

	Groups	N	Mean ± Std
Gingival	Fuji IX	n= 15	17.72 ± 1.42
	Zirconomer	n= 15	10.34 ± 1.23
	Riva	n= 15	7.23 ± 1.45
	Xtracem-S	n= 15	4.35 ± 0.45
Occlusal	Fuji IX	n= 15	17.65 ± 1.30
	Zirconomer	n= 15	10.44 ± 1.11
	Riva	n= 15	7.13 ± 1.45
	Xtracem-S	n= 15	3.55 ± 0.33

Discussion

An essential characteristic that has been utilized to evaluate the effectiveness of any restorative material used in tooth restorations is microleakage. A significant problem in clinical dentistry is microleakage, which is defined as the clinically discernible movement of germs, chemicals, fluids, or ions between a cavity wall and the restorative materials applied to it. This could happen as a result of temperature variations, mechanical stress, or the restorative material not adapting, leaving a gap at the tooth material junction.[10] When it comes to cervical lesions, the restoration's coronal borders are often made of enamel, while the cervical margins are made of dentin or cementum. The cervical region experiences occlusal stress during both normal and parafunction, which could worsen the margins of Class V restorations or promote microleakage. The amount of hydroxyapatite in enamel is considerable, while the amount of organic tissue is smaller. Conversely, dentin is composed of two distinct substrates: the more mineralized peritubular dentin and the less mineralized intertubular dentin. Water in the dentin reduces surface energy and makes it difficult for restorations to achieve enough mechanical retention. So, class V cavities were selected for research on microleakage.[11]

Glass ionomer cements are bioactive adhesive restorative materials having a therapeutic effect that were created in the latter part of the 1960s.Combining the greatest qualities from silicate cements, composite resins, and polycarboxylate cements was the goal of Wilson and his colleagues' creation of the glass-ionomer cements and McLean and Wilson's development of them for clinical application. While it is more resistant to acid attack, the glass-ionomer cement shares strength properties with silicate cement. Similar to polycarboxylate cements in that it is bland, but it has the extra benefit of being translucent.[12] Limited invitro studies available for the experimental materials- Zirconomer Improved and Xtracem-S regarding evaluation of microleakage. The anticariogenic property resulting from fluoride release turned out to be the most attractive aspect of this dental material as it prevents the occurrence of secondary caries. Fluoride is thought to act by aiding the remineralization of damaged enamel.

The results of this study revealed XTRACEM-S (GROUP 4) showed least microleakage among the four glass ionomer cements at the significant level. Riva self cure (GROUP 3) also showed less microleakage than Zirconomer Improved (GROUP 2) (p=.006) and FujiIX (GROUP 1) (p=.000) which was statististically significant and a comparable microleakage as XtraCem-s (GROUP 4) which was not statistically significant. Highest microleakage was seen with Fuji IX (GROUP 1). In this study, FUJI IX (GROUP 1) showed the highest microleakage. Previous studies showed that the microleakage of zirconia reinforced glass ionomer (Zirconomer) was slightly higher than that of conventional glass ionomer cement (Shameera et al 2017).[13] One explanation to this is the large size of the filler particle in Zirconomer which prevents proper adaptation of this material to the tooth surface. Zirconomer appears opaque clinically. To improve the esthetics, nano zirconia filler reinforced glass ionomer cement (Zirconomer Improved) has been introduced which imparts translucency. The influence of formulation changes on marginal sealing ability should be investigated for this glass ionomer cements. Pertaining to zirconomer improved, no previous studies on microleakage were found on literature search. Shetty et al (2017)[14] evaluated and compared the compressive strength of restorative materials Ketac Molar, Zirconomer, and Zirconomer Improved. All the tested restorative materials exhibited sufficient compressive strengths with Zirconomer exhibiting significantly higher compressive strength.

Riva self-cure (GROUP 3) showed a comparable microleakage as that of Xtracem-s (GROUP 4) in this study. This might be due to the high viscocity nature of the cement which provides better bonding. Riva Self Cure does not contain resin eliminating the problem of volumetric shrinkage after curing. Hence, microleakage associated with shrinkage does not occur (Duong et al, 2008).[15] Riva Self Cure utilizes SDI’s proprietary ionglass filler, a radiopaque, high ion releasing, bioactive glass which releases substantially higher fluoride to assist with remineralization (Mc cabe et al, 2008). Nurulnazra et al (2017)[16] compared four commercially available conventional GIC -Fuji VII, Riva Protect, Riva Self Cure and Fuji IX GP Extra respectively based on the amount of fluoride release, marginal integrity using dye penetration under stereomicroscopic evaluation. In this study, low-viscosity GICs exhibited more microleakage compared to the high-viscosity variants. There was a statistically significant association between degree of microleakage at restorative margins with the type of the materials. Samples from Fuji VII and Riva Protect had more microleakage at 2^o and 3^o, whereas Riva Self Cure and Fuji IX GP Extra samples had more microleakage at 1^o and 2^o. The least number of samples with 4^o microleakage were from Riva Self Cure and Fuji IX GP Extra.

Conclusion: The in vitro study's overall results allow for the following conclusions to be drawn. The product with the least microleakage was Xtracem-S, followed by Riva self-cure, with no discernible difference between the two. Compared to Xtracem-S and Riva self-cure, Fuji IX and Zirconomer Improved displayed comparable microleakage levels that were noticeably higher. Since the current work was conducted in vitro, more research on microleakage assessment in clinical trial and simulation conditions is required.

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