Comparative evaluation of microleakage of three different restorative materials (Cention N, Zirconomer improved and Glass hybrid restorative system) in Class V cavity restoration using stereomicroscope: In vitro study

ABSTRACT

Aim and Objective: *Microleakage is the most important factor responsible for the destruction of restoration margins. The aim of this study was to compare and evaluate the microleakage of three different restorative materials namely glass hybrid restorative system, zirconomer improved and Cention N under stereomicroscope.*

Materials and Method: *In this in-vitro experimental study, 45 Class V cavities were prepared on the buccal surface of maxillary premolars. The prepared cavities were divided into three groups for restoration with Cention N(group I), Zirconomer Improved(group II), Equiaforte (group III). All the samples were thermocycled for 500 cycles between 5-55°C initially and then immersed in 0.5% methylene blue for 24 hours before sectioning. All the sectioned samples were observed for microleakage under a stereomicroscope.*

Results: *Data was analyzed using one way ANOVA test for comparison between three groups and the result revealed statistically significant difference between the groups($p<0.05$). Post hoc Tukey test was used for intergroup comparison and it was observed that both Cention and Equiaforte are inferior to Zirconomer improved in terms of microleakage($p<0.05$).*

Conclusion: *Zirconomer improved exhibited lower microleakage when compared to Cention N and Equiaforte cements.*

Keywords: *Cention N, Equiaforte, Microleakage, Zirconomer improved.*

1. INTRODUCTION

Class V lesions are those occurring at the cervical aspect of the buccal or lingual surfaces of teeth. Conventionally, based on the etiology, a class V lesion is broadly classified as carious and non-carious lesions[1]. In children, class V lesions are commonly associated with caries. The development of different restorative materials presents the modern dentist with several choices when deciding how best to restore cervical cavities on teeth. Composite resin (in different formulations), glass ionomer, resin modified glass

ionomer (RMGI), alkaline fillers and compomer may all be considered appropriate restorative materials for class V restorations[2]. However, despite all these advances in the restoration of lesions, class V restorations are less durable than other classes of restorations[3].

Failure of class V restorations are mainly due to microleakage, because the margins of the class V restorations are located near to dentin / cementum and the dentinal bonding is less to be expected than enamel due to its lower mineral content and complex pattern[4]. Due to thermal alteration in oral cavity, volumetric change in restorative material occur, which creates gap between the restorative material and tooth structure, also resulting in microleakage[5].

Numerous studies have shown that marginal microleakage may cause marginal staining, secondary caries around restorations and lead to pulpal pathology[6,7]. Therefore, less microleakage has been a key to the success in operative dentistry[8].

Cention N, Zirconomer improved and Equiaforte are recently added materials to the market to aid restorative dentistry.

Cention N is an “alkasite” restorative material, introduced in 2016. As a dual-cured material, it can be used as a bulk replacement material. Optional light curing is carried out with blue light in the wavelength range of approximately 400–500 nm[9].

Alkaline filler has been used as a newer category filler, which releases acid-neutralizing ions. It also includes a special patented filler (isofiller) which acts as a shrinkage stress reliever minimizing the shrinkage force. Cention N is radiopaque, which releases fluoride, calcium, and hydroxide ions where the powder and liquid are separately packed that are mixed before use. One drop of liquid is mixed with one scoop of powder. The liquid comprises of dimethacrylates and initiators, while the powder contains various glass fillers, initiators, and pigments[10].

Shofu introduced a modified glass ionomer cement (GIC) with zirconia named Zirconia reinforced GIC (zirconomer improved). They are also known as white amalgam. Zirconia is a high-strength ceramic in which powder contains fluoroaluminosilicate glass, zirconium oxide, pigments and others,while liquid have polyacrylic acid and tartaric acid solution[11].

Incorporation of zirconia helps to achieve greater compressive and flexure strengths, as well to attain less occlusal wear and fast setting reaction, excellent marginal adaptation and resistance to abrasion and erosion, sustained fluoride release, and durability of silver amalgam without the hazards of mercury.

Zirconomer improved is formulated with zirconia nano fillers which give better translucency than zirconomer for more natural colour[11].

Glass hybrid restorative system (equiaforte) contains fluoroaluminate silicate glass, polyacrylic acid, surface treated glass, polybasic carboxylic acid, water. Equia forte provides a good mechanical and physical properties like high wear resistances to acid, high fluoride release and high flexural strength.

The upgraded equia forte has added micron sized fluoroaluminosilicate fillers to the standard one. The addition of these highly reactive fillers leads to release more fluoride and metal ions and improve the physical properties of the set material. Another modification includes a light-cured, nanofilled resin coating (Equia forte coat). This modernized coat have a new highly reactive multifunctional monomer that has thinner film layer, more wear resistance and adds lustrous smooth surface to the final restoration[12].

Several previous studies have compared microleakage in class V restorations using different restorative materials. In the study done by Sadhegi M et al(2012)[13], EMBRACE WetBond was compared with flowable compomer, microhybrid and nanofilled composite resin and it was observed that EMBRACE WetBond with acid etching and bonding agent had significantly less microleakage at the occlusal margins than those without, but not at cervical margins. In the study done by Nematollahi H et al(2017)[14], wherein different combinations of RMGI, flowable and nanohybrid composite were compared, it was observed that adding a thin layer of flowable composite or RMGI under nanohybrid composite in class V cavities did not decrease the bacterial leakage rate. In the study done by Salman K M et al(2019)[15] which evaluated the adaptability of Nano-ionomer with resin-modified glass ionomer, Zirconomer and Giomer to tooth surface by measuring the degree of microleakage in class V restorations, it was observed that all the restorative materials showed microleakage to an extent. From the above studies, it is clear that restorative dentistry is still in search of an ideal material that exhibits good adaptability and decreases microleakage of class V restorations.

The aim of this study is thus to compare and evaluate the microleakage of three different restorative materials namely Cention N, Zirconomer improved and Glass hybrid restorative system under stereomicroscope by using dye penetration method in class V cavities.

2. MATERIALS AND METHOD:

About 45 human maxillary and mandibular premolars (extracted for orthodontic purposes) without caries, cracks and no previous restorations were included in this study. The sample was decided based on the mean microleakage values of previous studies.

2.1. Sample size calculation:

The collected samples were cleaned and stored in distilled water at 4°c until use. Class V cavity were prepared using high-speed flat end straight diamond bur (SF-41 ISO 109/010 Mani Dia burs) with water coolant on the buccal surface with standardization of 3 mm width, 3 mm height, and 1.5 mm depth. A graduated William's probe was used to measure the dimensions of the cavities. The preparations were randomly divided into three equal groups of 15 cavities each. The samples were categorized into three groups as:

Group I –Cention N
Group II - Zirconomer improved and
Group III - Glass hybrid restorative system (Equiaforte)

The procedure of random allocation of samples to the three groups, cavity preparation, restoration and associated measurements were standardized for all groups and performed by a single researcher to avoid bias.

Samples in Group I were etched using Scotchbond multi-purpose etchant (3m ESPE), washed with water jet and dried with gentle stream of air leaving a moistened surface. A layer of Tetric N bond (IvoclarVivadent) was then applied using a disposable microbrush, and light cured for 10s and samples were restored using Cention-N (Ivoclar,Vivadent). Dosing, mixing and restoration of the cavity were strictly according to manufacturer instructions. For group II (Zirconomer improved) powder and liquid ratio for each sample was 3.6 / 1.0 (2 scoops: 1 drop), dispensed on the mixing pad with working time: 1min 30 sec (from start of mixing) and then it was placed on the cavity by means of plastic instrument incrementally and condensed. In case of group III (Equiaforte), one end of the capsule which is to be placed on the applicator was pressed against the firm surface to loosen the powder, following this the capsule was positioned in the amalgamator for mixing with dwell time of 10sec. Immediately capsule was

placed into a capsule applier and the lever was clicked until the cavity was completely filled by the material.

After this, the samples were subjected to thermocycling of 500 cycles between 5-55 degree celsius with a dwell time of 30sec. This was done to simulate oral conditions[16]. The samples were then prepared for dye immersion by coating each sample with finger nail varnish, with the exception of a 0.5-1.0 mm window around the restoration margins and sealing the apices with sticky wax. According to Patel et al[17], the teeth were immersed in 0.5% methylene blue dye for 24 hours. Later the samples were split longitudinally in a buccolingual direction. The microleakage was assessed by viewing all the samples under stereomicroscope (Figure:1) at a magnification of 40x.

Figure :1 Stereomicroscope

The scoring criteria for the microleakage assessment (Figure:2a,2b,2c) were followed according to Vinay S and Shivanna V (2010)[18]

0 = no dye penetration.

1 = dye penetration up to 1/3rdcavity depth

2 = dye penetration up to 2/3rdcavity depth

3 = dye penetration to full depth of cavity

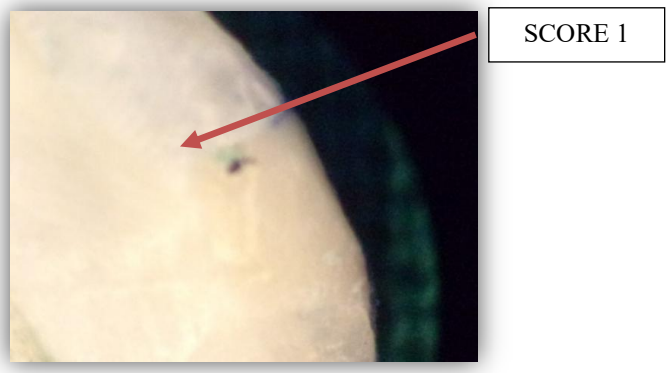


Figure: 2a Stereomicroscope images showing microleakage of score 1

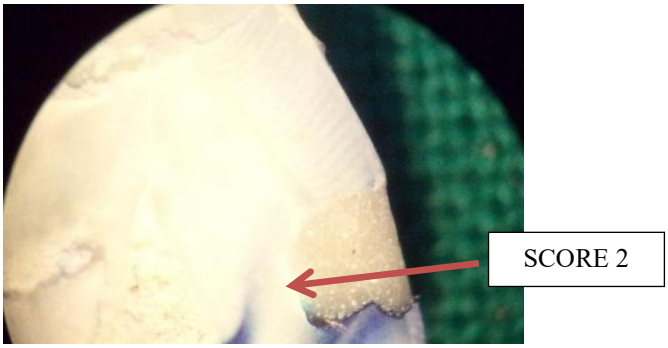


Figure: 2b Stereomicroscope images showing microleakage of score 2

Figure: 2c Stereomicroscope images showing microleakage of score 3

2.1. STATISTICAL ANALYSIS:

Descriptive statistical analysis was performed to calculate the mean with corresponding standard deviation. One-way analysis of variance(ANOVA) followed by post hoc Tukey's test was performed with the help of critical difference (CD) or least significant difference at 5% and 1% level of significance to compare the mean values. $P < 0.05$ was considered to be statistically significant.

3. RESULTS:

Table 1 shows the mean and standard deviation of microleakage of three different restorative materials considered in the present study. Samples in group III (Equiaforte) exhibited the highest mean value(2.20) followed by Cention and Zirconomer improved. Zirconomer improved exhibited the least mean microleakage among the three restorations.

Table 1:-Distribution of mean values of Microleakage in all groups

	N	*Mean*	*Std. Deviation*	*Std. Error*
Cention N (Group I)	15	1.93	0.594	0.153
Zirconomer improved (Group II)	15	1.07	0.594	0.153
Equiaforte (Group III)	15	2.20	0.676	0.175
Total	45	1.73	0.780	0.116

Table 2 shows the comparison of mean microleakage of the three restorative materials using One way ANOVA test. The result was statistically significant indicating that there exists a significant difference in the mean values of the three restorative materials included in the study($p<0.05$).

Table 2:-Comparison of mean microleakage between groups- One way ANOVA test

		Sum of Squares	*Degree of freedom*	*Mean Square*	*F*	*P value*
Microleakage	Between Groups	10.533	2	5.267	13.598	<.001**

	Within Groups	16.267	42	0.387
	Total	26.800	44	

***Highly significant*

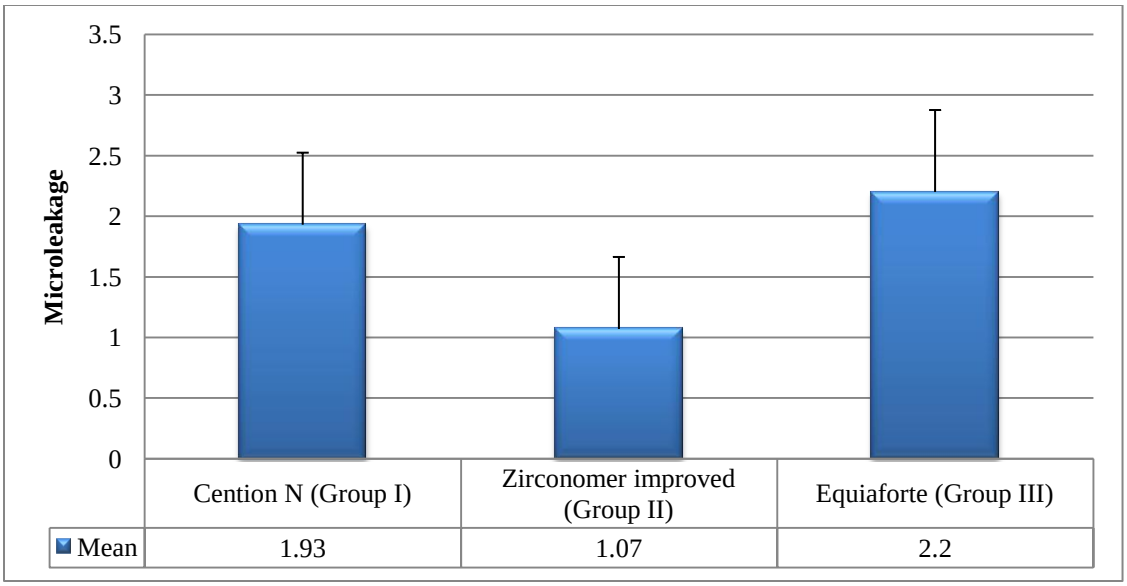
Table 3 shows the pairwise comparison of the mean microleakage between Cention, Zirconomer improved and Equiaforte using Tukey's post hoc test. It is observed that both Cention and Equiaforte are inferior to Zirconomer improved in terms of microleakage($p<0.05$). However no statistically significant difference was found between Cention and Equiaforte.

Table 3:-Inter Comparison of microleakage between groups - Tukey's HSD post hoc test

(I) group	*(J) group*	*Mean Difference (I-J)*	*Std. Error*	*P value*	*95% Confidence Interval of mean difference*	
					Lower Bound	Upper Bound
Cention	Zirconomer improved	0.867	0.227	<.001**	0.31	1.42
	Equiaforte	-0.267	0.227	0.48	-0.82	0.29
Zirconomer improved	Cention	-0.867	0.227	<.001**	-1.42	-0.31
	Equiaforte	-1.133	0.227	<.001**	-1.69	-0.58
Equiaforte	Cention	0.267	0.227	0.48	-0.29	0.82
	Zirconomer improved	1.133	0.227	<.001**	0.58	1.69

***Highly significant*

Graph 1 : Mean microleakage of three materials considered in the study



Thus the study observes that Zirconomer improved (Group II) showed the least mean microleakage compared to other groups while group III showed the highest mean value.

4. DISCUSSION:

Dr. GV Black's 'extension for prevention' manoeuvre has made great progress in restorative dentistry from dental amalgam fillings to the minimally invasive micro-retention of adhesive composite fillings and chemically bonded restorations such as glass ionomers. As a result of minimal removal of sound tooth structure endurance time for the restorative material remains longer[19,20].

Major problem in restorative dentistry stands out to be microleakage as it has been related to pulp alterations, sensitivity and secondary caries, which leads to failure of restoration (Manhart et al., 2001)[21].

To determine durability of the restorative material, dye penetration test is used by clinicians and researchers. Regardless of its limitation, dye penetration method was used in this study because they are considered to be still popular to determine microleakage. They also have a benefit of low cost and simplicity of technique[22].

Numerous methods used to detect microleakage, dye penetration with methylene blue has confirmed to be a time-tested method. Methylene blue (0.5%) has low molecular weight known to be smaller than bacteria, it helps to determine leakage in places where even bacteria cannot penetrate[23].

Persistence of Class V restorations is minimal, suggesting that in this kind of restoration the performances of the tested GIC system were most challenged. Chemical resistance and self adhesion define glass ionomer cement as reliable material for Class V restorations[24].

Similar to glass ionomer cement (GIC) cention N discharges fluoride and more esthetic material as a result of its higher transparency of 11% in accordance to GIC which presents transparency of 3–4%[25-27].

In this present study, zirconomer Improved exhibits lesser microleakage value when compared to cention N and hybrid ionomer cement (Equiaforte) statistically significant with p value of less than 0.05%. It might be due to incorporation of zirconia fillers which is an uneven compound and hence deviations its phase from monoclinic to tetragonal and then to cubic and vice versa thereby increasing in volume counteracting the volumetric shrinkage expressed during polymerization[28-30].

It is contradictory to the study conducted by Talat Naz et al in which they concluded the mean microleakage of Zirconomer Improved was found to be more than Cention N. Contradiction results may be due to variation in selection of tooth samples, storage time, type of cavity preparation which will affect the microleakage[31].

Present study is similiar to the study conducted by Albesti et al who concluded that Zirconomer Improved displayed minimum microleakage when tested by dye penetation method. It could be due to that incorporation of zirconia fillers would cause interference in the chelating reaction between the carboxylic group (- COOH) of polyacrylic acid and the calcium ions (Ca2+) of tooth apatite[32].

In contrary to this study Sahadev CK et al, who showed a significant lower microleakage for cention N than zirconomer. The authors attributed this result due to incorporation of organic/inorganic ratio and the monomer composition of the material, validation for its low volumetric shrinkage[33].

In this study cention N displayed relatively lesser microleakage than equiaforte which exhibit higher microleakage. It is incongruous to the study revealed by Bharath M J et al,who found cention N displayed lesser microleakage than Equiaforte it could be due to Cention N has a distinctive patented isofiller, which is moderately functionalized by silanes which acts like a spring, enlarging to some extent as the forces between the fillers grow during polymerization. Hence, it pushes the material towards cavity walls which further leads to close adaptation and thus decreases the microleakage[34].

The study design is invitro and this forms a major limitation of the current study. The effect of Zirconomer improved on microleakage must be assessed under in vivo conditions to better determine the utility of the restorative material.

4. CONCLUSION

In this study, Zirconomer improved, a recently introduced restorative material, showed minimum microleakage compared to Cention N and Equiaforte. To overcome postoperative sensitivity as a result of marginal leakage, we are in need of better restorative materials and Zirconomer improved proves to be of use in any c restorations to improve longevity and prevent secondary caries.

5. RECOMMENDATIONS

Further in vivo studies are needed with larger number of samples to determine the masticatory forces, humidity variation, presence of salivary enzymes and bacterial by products which can affect the microleakage.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

Authors' Contributions

Author A is associated with the study concept, design, literature search, data acquisition and manuscript preparation,editing and review. Authors B,C,D and E are associated with designing of the study and manuscript review. Author F is associated with data analysis and interpretation.

Consent (where ever applicable)

Not applicable as it is an in vitro study.

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