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In Vitro Comparative Evaluation Of Microleakage In Class V Cavities Restored With Alkasite Restorative Material With And Without Bonding Agent, GIOMER, And Flowable Composite Resin

Dr. Nadendla Maneesha, Dr. Kiran J Kasti, Dr. Ananthakrishna S,
Dr. Pradeep P. R, Dr.Dhanushree D R, Dr. Claudia Dayanandini
Post Graduate Student, Department Of Conservative Dentistry And Endodontics, M.R Ambedkar Dental College And Hospital, Bangalore, India
Reader, Department Of Conservative Dentistry And Endodontics, M.R Ambedkar Dental College And Hospital, Bangalore, India
Professor And HOD, Department Of Conservative Dentistry And Endodontics, M.R Ambedkar Dental College And Hospital, Bangalore, India
Professor And Principal, Department Of Conservative Dentistry And Endodontics, M.R Ambedkar Dental College And Hospital, Bangalore, India
Post Graduate Student, Department Of Conservative Dentistry And Endodontics, M.R Ambedkar Dental College And Hospital, Bangalore, India
Post Graduate Student, Department Of Conservative Dentistry And Endodontics, M.R Ambedkar Dental College And Hospital, Bangalore, India

Abstract
Aim: *To evaluate microleakage at enamel restoration and dentin restoration interface of Class V cavities restored with alkasite restorative material Cention- N, with and without using bonding agent,GIOMER and flowable composite resin.*
Materials And Methods: *Forty Class V tooth preparations were done on permanent maxillary and mandibular 1st molars and divided into four groups*
Group- 1: *restored with Cention- N (Ivoclar Vivadent) without adhesive*
Group- 2: *restored with Cention- N after application of eighth- generation bonding agent (3M) ESPE, Single Bond Universal Adhesive)*
Group- 3: *restored with flowable composite resin (Tetric- N- Flow, Ivoclar Vivadent)*
Group- 4: *restored with GIOMER*
All samples were subjected to 200 thermocycles between temperature baths at 5°C and 55°C. All samples were cut longitudinally through the center of the restorations with the help of isomet diamond disc. The sectioned half showing more microlekage were then observed under stereomicroscope.
Results: *The results showed cention-N with bonding agent showed less microlekage compared to other restorative materials which is cention-N without adhesive,flowable composite and GIOMER*
Conclusion: *Microleakage of Cention-N with bonding agent is less compared to other restorative materials. GIOMER showed less microlekage than flowable composite, & cention- N without bonding agent. Flowable composite & cention-N without bonding agent did not show much mean difference*
Keywords: *Centoin-N, Flowable composite, Bonding agent,Giomer*

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I. Introduction

The marginal seal of a restoration is one of the key components that determine its success. Class V cavities are always difficult to restore at the dentin contact because there is no enamel there to form a connection. Bonding is more challenging in dentin near the gingival margin due to its higher organic components, tubular structure, fluid pressure, and lower surface energy compared to enamel.[1].One of the most important requirements for a successful restoration is preventing microleakage, which is achieved by making sure the restorative material binds to the cavity walls effectively.[2]The inability of the restorative materials to achieve the full marginal seal results in microfissures, which allow ions, fluids, and bacteria to seep in and cause pulpal infections, secondary decay, and sensitivity.[3]The ongoing search for improved restorative

materials led to the introduction of novel materials with improved biomechanical qualities, including improved marginal seal, good aesthetics, easy polishability, biocompatibility, and compressive strength over time.

Previously, Class V cavities were restored using amalgam and gold restorative materials, however, these methods were rendered obsolete mostly because to their aesthetic drawbacks.[5] Later glass ionomer cement was used but due to limited abrasion resistance, insufficient hardness, and fracture resistance.newer hybrid esthetic restorative material Giomer was introduced with the physical properties and biocompatibility of composite resin.Giomer is based on prereacted filler technology, which strengthens prereacted glass particles to the resin matrix to reinforce it.[4]

For a number of adhesive restoration techniques, including class V restorations, flowable composites have been recommended. Despite being commonly utilized for restorations, flowable composite resins have limitations, such as polymerization shrinkage.[6]This shrinkage affects the longevity of dental restorations by creating a gap between the tooth and the restoration leading to additional problems such as pulpal inflammation, hypersensitivity, recurrent caries at the tooth restoration interface, and marginal discoloration of the restored tooth.[7]

Cention-N, a restorative alkasite [Ivoclar Vivadent]. It is a part of the composite resin materials subgroup, which also includes compomer and ormocer. The percentage of inorganic filler in Cention-N is 78.4%. Alkaline glass constitutes 24.6% of the total weight of the final material. This restoration releases a significant amount of fluoride ions, comparable to traditional glass ionomer cements (GICs).It is a tooth-colored, dual-cured restorative material that comes in liquid and powder form.[6]

Thus, the present in vitro study was undertaken to compare microleakage around Class V Cavities Restored with Alkasite Restorative Material with and without Bonding Agent,GIOMER and Flowable Composite Resin

II. Materials & Method

Forty human permanent maxillary and mandibular first molars were selected. Selection criteria for teeth were absence of caries, restoration, and with no visible cracks Class V tooth preparations made on buccal surface of molars and were divided into four groups

GROUP 1 restored with Cention N (Ivoclar Vivadent) without adhesive, GROUP 2 restored with Cention N after application of bonding agent GROUP 3 restored with flowable composite resin GROUP 4 restored with GIOMER

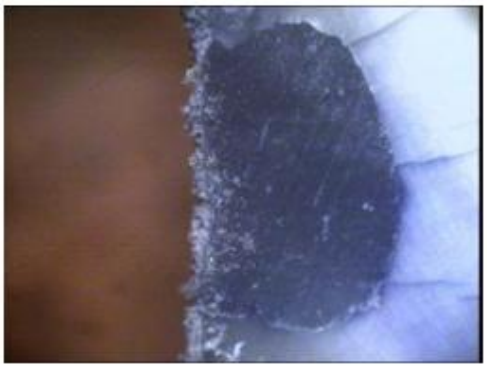
The preparation was standardized to 2 mm in depth, 4 mm mesio distal width, and 2 mm height in occluso gingival direction

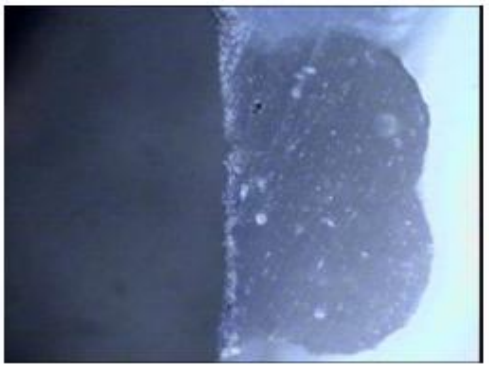
All samples were subjected to thermocycling between temperature baths at 5°C and 55°C. The samples were immersed in methyleneblue dye for 24 h at 37°C. Then they were washed for 1 min under running tap water and dried. An isomet diamond saw was used to cut the teeth longitudinally through the center of the restorations under water coolant. The sectioned half showing more microlekage were then observed under stereomicroscope. scored the depth of dye penetration is scored independently. Scoring pattern used was similar to that used by Munro, Hilton, and Hermesch [1]. Value and its inference used in the present study are as follows

SCORE 0 – No evidence of microleakage

SCORE 1 – Dye penetration up to half of cavity depth

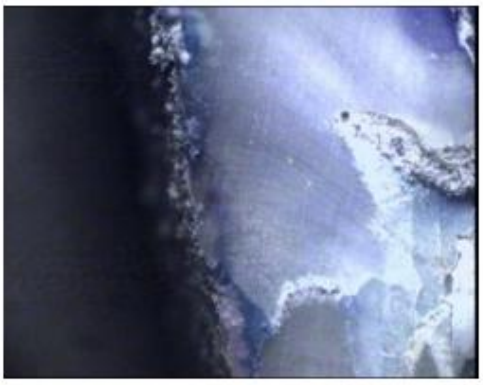
SCORE 2 – Microleakage more than half of the depth of cavity wall SCORE 3 – Dye leakage involves axial wall





Cention-N Without bonding agent

Cention-N with bonding agent



GIOMER

Flowable composite

III. Results

Null Hypothesis [H0] – There is no difference in the mean Micro Leakage scores between 4 groups.
Alternative Hypothesis [HA] – There is a difference in the mean Micro Leakage scores between 4 groups

Comparison of mean Micro Leakage Scores b/w 4 groups using Kruskal Wallis Test						
Groups	N	Mean	SD	Min	Max	p-value
Group I	10	2.30	0.68	1.0	3.0	<0.001*
Group II	10	0.60	0.52	0.0	1.0	
Group III	10	2.10	0.88	1.0	3.0	
Group IV	10	1.30	0.48	1.0	2.0	

* - Statistically Significant

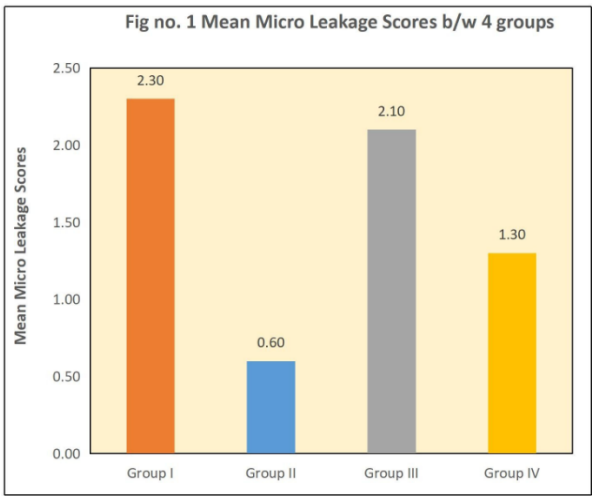
Note: Group I – Restored with Cention N (Ivoclar Vivadent) without adhesive; Group II – Restored with Cention N after application of eighth generation bonding agent (3M ESPE, Single Bond Universal Adhesive), Group III – Restored with flowable composite resin (Tetric N Flow, Ivoclar Vivadent), Group IV – Restored with GIOMER.

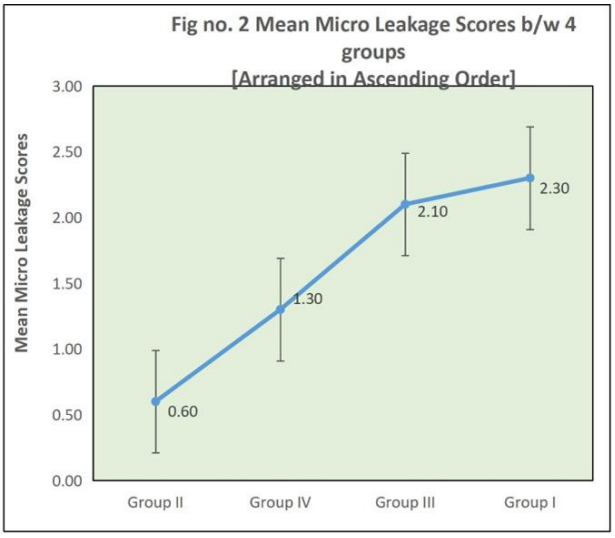
The test result showed the mean Micro Leakage scores for Group I was 2.30 ± 0.68, Group II was 0.60 ± 0.52, Group III was 2.10 ± 0.88 and Group IV was 1.30 ± 0.48. The difference in the mean Micro Leakage scores between 4 groups was statistically significant at p<0.001. [Refer Fig no. 1]

Multiple comparison of mean difference in the Micro Leakage Scores b/w groups using Dunn's Post hoc Test					
(I) Groups	(J) Groups	Mean Diff. (I-J)	95% CI for the Diff.		p-value
			Lower	Upper	
Group I	Group II	1.70	0.91	2.49	<0.001*
	Group III	0.20	-0.59	0.99	0.57
	Group IV	1.00	0.21	1.79	0.01*
Group II	Group III	-1.50	-2.29	-0.71	<0.001*
	Group IV	-0.70	-1.49	0.09	0.04*
Group III	Group IV	0.80	0.01	1.59	0.04*

* - Statistically Significant

Multiple comparison of mean differences between groups showed that Group II showed significantly least mean micro leakage scores as compared to Group I, followed by Group III and Group IV and the mean differences were statistically significant at p<0.001, p<0.001 & p=0.04 respectively. This was then followed next with Group IV showing significantly lesser mean micro leakage scores as compared to Group I & Group III and the mean differences were statistically significant at p=0.01 & p=0.04 respectively. However, there was no significant difference in the mean micro leakage scores between Group I & Group III [p=0.57]. This infers that the Group II demonstrated significantly least mean micro leakage scores, followed by Group IV, Group III and highest in Group I. [Refer Fig no.2].





IV. Discussion

One of the primary reasons of pulpal pathosis, recurrent caries, and post-operative sensitivity is microleakage between the cavity wall and the restorative material.

Careful placement of restorative material is necessary for the restoration of Class V cavities, particularly at the cervical wall where only dentin is present.

The tooth and restorative material exhibit microleakage because micromechanical locking is restricted to surface roughness brought on by diamond burs during tooth preparation.[2]

Less leakage occurred (refer graph1) between the restoration and the tooth structure in cavities filled with Cention-N with adhesive because the contact is mostly sealed as an acid- resistant resin-dentin interdiffusion zone, i e hybrid layer.Priyatama Meshram et al also concluded that Centoin -N with bonding agent shows less microlekage[8]

Using a bonding agent lowers shrinkage stress at the interface, minimizing marginal gaps even though Cention-N has lower polymerization shrinkage (1.7%–2.5%) than conventional composites..Bonding agents enhance the chemical bonding between the monomer in Cention- N (UDMA-based) and the tooth surface.[1]

Because self-etch primers are bonded to dental hard tissues by a combination of chemical and micromechanical interaction with the tooth substrate, GIOMER(refer graph 2) exhibits less microleakage than groups 1 and 3.Archana harI et al also concluded that giomer shows less microlekage than flowable composite[9]

The bond system comprises 4-AET Acid (4-Acryloxyethyltrimellitic acid), which interacts with the calcium cations of hydroxyapatite to generate 4-AETCa, a relatively insoluble calcium (Ca) salt that may increase the adhesive system's durability.[10]

There are two explanations for why class V cavities are repaired using giomer. According to Diliperi et al., "Mild" self-etch primers don't work well for etching enamel. In order to get around this, Torii et al. suggested using phosphoric acid for additional enamel etching after using a mild self-etch primer.[4]

Giomer restorative materials tend to exhibit more microleakage compared to Cention-N used with a bonding agent due to differences in adhesion, polymerization shrinkage, and marginal seal integrity. Cention-N, when combined with an adhesive, provides both micromechanical and chemical bonding to the tooth substrate, resulting in improved sealing at the margins. In contrast, giomer depends on a separate bonding agent, and any inconsistency in its application can lead to micro-gap formation. Additionally, giomer, being a resin-based composite, undergoes greater polymerization shrinkage, which contributes to marginal leakage. Cention-N, an alkasite restorative material, has a lower polymerization shrinkage due to its unique monomer matrix and the presence of isofillers that relieve shrinkage stress, enhancing its marginal adaptation. While giomer materials contain surface pre-reacted glass- ionomer (S-PRG) fillers that release fluoride, this does not directly correlate with marginal sealing effectiveness. Studies by Shafiei and Tavangar demonstrated that the use of adhesives significantly improves the sealing ability of materials like Cention-N [16]. Ilie and Hickel found that alkasite materials exhibit lower polymerization shrinkage stress than giomers [17]. Furthermore, Hegde et al. reported that giomer showed significantly higher microleakage than Cention-N when used with bonding agent [18]

Because there is less filler in flowable composite resin, it has a low viscosity, good flowability, and a coefficient of thermal expansion that is comparable to that of the tooth structure. They absorb polymerization shrinkage and can undergo plastic deformation due to their low modulus of elasticity. They flow, are low

viscous, and contain a lot of resin.Shrinkage causes stress at the margins, pulling away from cavity wall .Loguercio AD et al also stated that flowable composite showed more microlekage(refer graph 1) compared to other restorative materials[12]

Flowable composites are designed with lower viscosity to improve adaptability to cavity walls, but this comes at the cost of reduced filler loading , making them more prone to volumetric shrinkage during polymerization. This shrinkage can create stress at the tooth- restoration interface, resulting in microgaps and subsequent leakage. In contrast, Cention-N, an alkasite restorative material, features higher filler content, low shrinkage , and is used with a bonding agent that enhances marginal seal through both micromechanical and chemical adhesion. Similarly, Giomer contains S-PRG (surface pre-reacted glass) fillers and, when bonded properly, provides better seal than flowables, though still less effective than Cention-N. Studies by Ilie and Hickel have confirmed that flowables have higher shrinkage stress than bulk-fill or alkasite materials [17], while Hegde et al. reported higher microleakage in flowables compared to Giomer and Cention-N with bonding [18]. Additionally, Cention-N's inclusion of isofillers helps reduce polymerization stress, which is absent in traditional flowables [12].

Cenetoin N without adesive shows more microlekage(refer graph 2) because though it is a self-adhesive material its adhesion to dentin/enamel is weak without bonding. and it lacks chemical interaction or hybrid layer formation.[13]

These results are similar with the studies done by Priyatama Meshram et al and Ramachandra Sujith et al. However the results showed less microlekage is group 2 followed by group 4 and group 3 and group 1

V. Conclusion

Within the limitation of this in vitro study, the following conclusions can be drawn.

1. Microleakage of Cention-N with bonding agent is less compared to other restorative materials.GIOMER showed less microlekage than flowable composite,&Cention-N without bonding agent
2. Flowable composite & Cention-N without bonding agent did not show much mean difference

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