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MICROLEAKAGE: COMPARITIVE EVALUATION WITH COMPOMER, KETAC MOLAR AND COMPOSITE

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Abstract
Aim: This study sought to assess microleakage in Class V cavities repaired with compomer, ketac molar and composite.
Material and Methods: Sixty extracted maxillary and mandibular premolar samples were taken out for orthodontic purposes and included in the in-vitro study. With the gingival margin positioned close to the cementoenamel junction (CEJ), a typical wedge-shaped defect was created on the buccal surfaces of the teeth. Following restoration with Compomer, Ketac Molar, and Composite, the teeth were thermocyclically processed and split into three groups of twenty teeth each. After that, the teeth were submerged in a 0.5% Rhodamine B solution for 48 hours. After separating the coronal and radicular sections, acrylic resins were used to embed the coronal portion. Next, the mesial and distal portions of the cavity were divided into longitudinal sections using acrylic blocks. Using a Confocal Laser Scanning Microscope (CLSM), we examined the slices at 10x magnification for evidence of the degree of dye penetration.

Statistical Analysis: A descriptive test, one-way ANOVA, and post hoc Tukey test were done for inter-group comparison. All statistical levels were made at p<0.001.

Result: Composite showed the least microleakage in Class V cavity restoration with a statistically significant difference to compomer and ketac molar. The intergroup comparisons were made at p<0.001.

Conclusion: The current study indicated that all three materials exhibit significant microleakage, with Ketac molar exhibiting the highest microleakage, followed by Compomer and Composite.

Keywords: Microleakage, Composite, Compomer, Ketac Molar

Introduction: In the last few decades, dentistry has undergone an enormous transformation, and this trend is quickening with the introduction of newer technology. Dental treatment procedures are being `advanced by innovations in materials, equipment, and techniques, which increase the likelihood of clinical success[1].Dental caries is one of the most common causes of loss of tooth structure, which impairs the shape and function of the affected tooth. Too much tooth structure is lost during traditional caries removal[2]. The preservation of tooth structure is crucial in the era of adhesive dentistry, or micro dentistry, where treatment guidelines have been extended for prevention and limitations with stance are now prominent.
Since the inception of restorative dentistry, one of the reasons for failure has been discovered as microleakage. Microleakage is known as 'the passage of bacteria, fluids or molecules between a cavity wall and the restorative material applied to it[3].Microleakage is particularly significant in Class V cavities due to the high "C" factor of the Class V restoration, which is the source of the internal bond breakdown and micro-fissures around the restorations and cavity walls[4]. Restorative marginal gaps that permit the ingress of oral fluids are considered a major reason for pulpal reactions and pulpal injuries (Branstrom 1984)[5]. The substantial biological effect of microleakage on a restored tooth may be the development of recurrent caries; which accounts for 50% of clinical failures in restorations. (Trowbridge 1987)[6].Fluid leakage may cause an acute reaction of the pulp following the placement of a restoration, leading to post-operative hyper-sensitivity and even acute pain (Youngson, Jones et al 1990)[7]. The symptoms are also attributed to fluid flow within the dentinal tubules which is due to the presence of microleakage.

Microleakage assays provide useful information on the performance and longevity of restorative materials in the oral cavity. It is an elemental goal to determine the microleakage of such materials to maintain the physiological integrity of the teeth. Hence the present study is aimed to compare and evaluate the microleakage between Compomer (Twinky star, Voco, Gmbh), Ketac molar (3M ESPE, USA) and Composite (Admira fusion, Voco, Gmbh).

Materials and Methods: This in vitro study was conducted in Mithila Minority College, Darbhanga, Bihar. 60 removed human mandibular or maxillary premolars were used in this in vitro investigation. The teeth were separated into three sets of twenty apiece. Teeth were randomly selected concerning the inclusion and exclusion criteria and were distributed into three experimental groups. In this investigation, human premolars removed for orthodontic purposes were used. The study eliminated teeth that had evident cracks, decay, fracture, abrasion, or structural abnormalities, or those that had received prior restorations. One week before restoration, teeth were scaled using an ultrasonic tool. Next, all of the teeth were kept in distilled water at room temperature after being sanitized for 24 hours with 0.5% chloramine. Utilizing an air/water spray, 008-diamond bur was used to create wedge-shaped flaws on the buccal surfaces of teeth.

The preparation had an occlusal margin in enamel and a gingival margin in cementum. It measured 4 mm in length, 4 mm in width mesiodistally, and 2 mm in depth. To avoid variability between operators, the same operator completed all cavity preparations and restorations. Following cavity preparation, the teeth within each group were randomly assigned numbers and split into three groups for the experiment (I, II, and III). Teeth in Group I were conditioned with Compomer (Twinky Star, Voco, Gmbh). Teeth in Group II were restored with Ketac Molar (3M ESPE, USA) which was taken as a control group. Teeth

in Group III were restored with the Composite (Admira Fusion, Voco, Gmbh) after the application of the bonding agent. Cavities were restored in incremental technique, with a minimum thickness of 1mm to minimize C-factor and polymerization shrinkage. Finishing and polishing of the restorations were performed using an extra-fine diamond point (Mani, Tochigi, Japan) and SofLex disks (Super-Snap Mini-Kit, Shofu).

Microleakage Testing: Following a day of 37ºC storage at 100% relative humidity, the specimens were subjected to 500 thermocycles at 5ºC and 55ºC, with a one-minute dwell duration at each temperature. The apices of all teeth were sealed using composite and all the teeth were covered with two coats of nail varnish except for 1-2mm except for the tooth-restoration interphase. Teeth were then plunged into 0.5% Rhodamine B dye for 48 hours. After separating the radicular portion with a slow-speed diamond disk, the coronal portions were washed and embedded into acrylic resin. Two mesial and distal sections were separated by a longitudinal segment taken buccolingually from the center of the hollow. A Carl Zeiss L880 Confocal Laser Scanning Microscope was used to examine each specimen to assess microleakage.

Statistical Analysis: The depth of dye penetration along the occlusal and cervical margins towards the pulpal wall was measured in millimetres using Image J Software Tool for Windows, v 3.0 software. Data was analyzed using SPSS version 23. A descriptive test, one-way ANOVA, and post hoc Tukey test were done for inter-group comparison. All statistical levels were made at $p<0.001$. Intergroup comparison of three restorative materials concerning microleakage showed significant differences (Table 1).Mean values of dye penetration for Group I (.478mm), Group II(.323mm), and Group III (.063mm) respectively.

Result: There is a statistically significant difference present in mean microleakage in various groups. One way ANOVA signifies overall comparison is to know the individual comparisons post hoc test should be done. (Table 1, 2)

Post Hoc Tukey test was done to determine the order of mean microleakage and it suggested that Ketac molar(3M ESPE, USA) shows the highest degree of microleakage followed by Compomer (Twinky star, Voco, Gmbh) and Composite (Admira fusion, Voco, Gmbh) (Table 3).

Table 1: A comparison of mean marginal leakage in various groups is listed-

Group	N	Minimum	Maximum	Mean	Std. Deviation	F value	P value
Compomer	20	.277	.381	.323	.037	761.505	<0.001**
Ketac molar	20	.395	.505	.478	.033		
Composite	20	.023	.099	.063	.032		

Comparison between		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Compomer	Ketacmolar	-0.155	.010760	<0.001**	-.17675	-.13365
Compomer	Composite	0.26	.010760	<0.001**	.23875	.28185
Ketac molar	Composite	0.415	.010760	<0.001**	.39395	.43705

Table 3: Order of mean microleakage (post-Hoc Tukey test)

Group	N	Subset for alpha = 0.05		
		1	2	3
Composite	20	.06250		
Compomer	20		.32280	
Ketac Molar	20			.47800

The degree of dye penetration was identified according to the criteria given by Wahab et al.[8] (Table 4).

0-no penetration;
1-penetration to the enamel or cementum aspect of the preparation wall
2-penetration to the dentin aspect of the preparation wall, but not including the pulpal floor
3-penetration including the pulpal floor of the preparation.

Table 4: Dye penetration score in Compomer, Ketac Molar and Composite

Dye penetration score	Compomer		Ketac molar		Composite	
	N	%	N	%	N	%
Score 0	0	0	0	0	0	0
Score 1	5	25.0	0	0	17	85.0
Score 2	12	60.0	7	35.0	3	15.0
Score 3	3	15.0	13	65.0	0	0
Total	20	100.0	20	100.0	20	100.0
Chi sq	44			P value	<0.001**	

CLSM shows fluorescence between restoration and tooth surface in Group II which indicates a poor adaptation of restorative material and Gap formation. [Fig-2] shows microleakage between restoration and tooth surface in Group III with a good adaptation of the material. [Fig-3] shows no microleakage between restoration and tooth surface in Group I which indicates the good adaptation of restorative material [Fig.1].

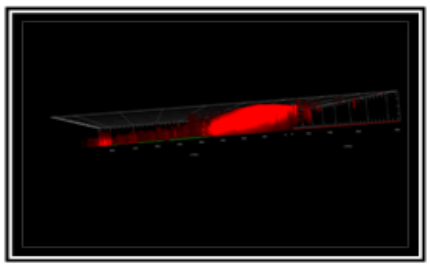

Fig1 (a) Compomer in tile scan

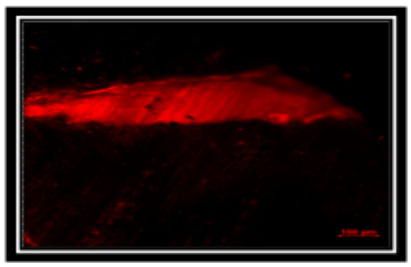

Fig1 (b) Compomer leakage in fluorescent mode

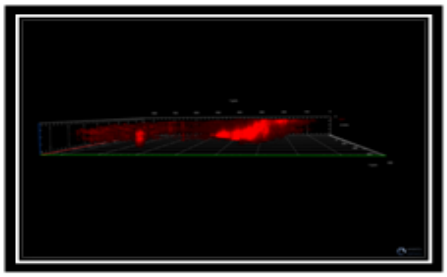

Fig2 (a) Ketac Molar in tile scan

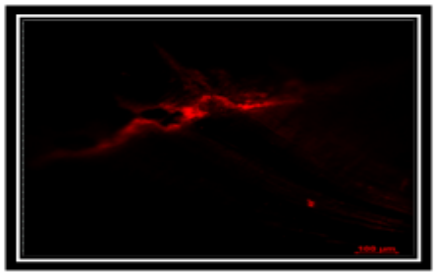

Fig2 (b) Ketac Molar leakage in fluorescent mode

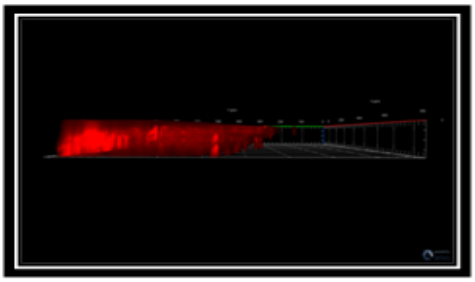

Fig3 (a) Composite in tile scan

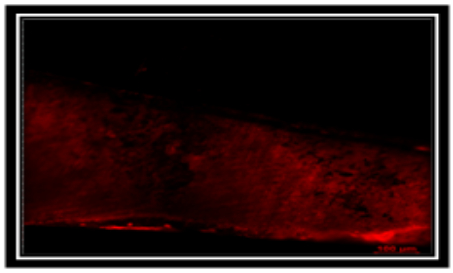

Fig3 (b) Composite leakage in fluorescent mode

Discussion: The long-standing "Extension for Prevention" approach established by Sir G.V. Black in restorative dentistry has given way to the more contemporary "restriction with conviction" principle. Despite all achieved progress in restorative dentistry, microleakage is still undesirable and appears hard to eliminate[9]. The microleakage is used as a criterion by which researchers and clinicians can predict the performance of a restorative material. The need for restorative material with better adhesive characteristics leads to the more recent advances in restorative materials.

Several studies have proposed different methods to evaluate the microleakage. Methods include dye penetration, dye extraction, radioactive isotope infiltration, acetate peel technique, bacterial leakage, neutron activation analysis, stereomicroscopic analysis, micro-computed tomography, confocal laser scanning microscopy and optical coherence tomography. All these accepted methods come with both advantages and disadvantages. CLSM in the present study is used for the evaluation of microleakage in Class V cavities and is used to obtain thin optical sections below the surfaces of the specimen[10].

Mass et al[11] compared compomer with amalgam restorations in primary teeth and they led to the conclusion that compomer may be recommended as an alternative to amalgam in primary molars. Also, the results agree with Marks et al[12]reported a 94% success rate for compomer after 3 years, an annual failure rate of 2% and comparable to success rates in permanent teeth. Marks et al[13] stated review recommends CP over AM, Hybrid CR and GIC based on the findings of primary studies.

Walia R et al[14] also evaluated and compared the microleakage and compressive strength of Ketac Molar, Giomer, Zirconomer, and Ceram-x and concluded that microleakage is insignificant for all groups. Giomer, Zirconomer, Ceram-x, and Ketac Molar had the highest sealing ability, whereas Giomer, Ceram-x, Zirconomer, and Ketac Molar had the highest compressive strength. Mahmoud et al[15] performed a 3-year evaluation on the clinical performance of ormocer, nano-filled, nanoceramic and micro-hybrid composites all performed excellently over the 3 years. Marcio et al[16] demonstrate that bonding agents and resin-based materials can exhibit excellent marginal seal for restoration of pulpotomized primary molar when compared with the amalgam.

Conclusion: Within the limitations of this study following conclusions can be made -

- None of the three materials were free from microleakage.
- Composite showed penetration to the enamel or cementum aspect of the preparation wall while Ketac Molar had penetration that included the pulpal floor of the preparation and Compomer degree of dye penetration is up to the dentin aspect of the preparation wall, but not including the pulpal floor.
- Among all the groups Composite (Admira Fusion, Voco, Gmbh) showed the least microleakage and less degree of dye penetration.

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