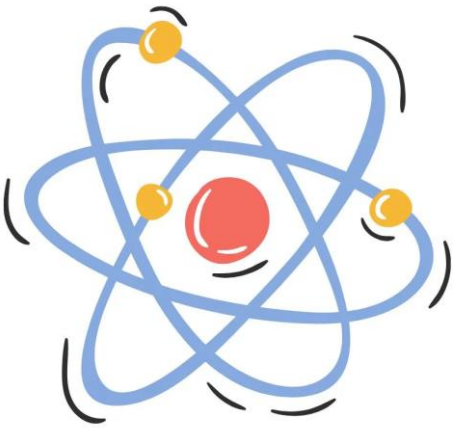

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MICROLEAKAGE MARVELS: COMPARATIVE SEM ANALYSIS OF MICROLEAKAGE IN ZOE VS GUTTAFLOW 2 SEALERS

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ABSTRACT - Aim*: The aim of this study was to evaluate the microleakage of two different endodontic sealers, Zinc Oxide Eugenol (ZOE) and GuttaFlow 2, using Scanning Electron Microscopy (SEM).* ***Objective****: The objectives were to evaluate the microleakage of ZOE and GuttaFlow 2, and to compare their sealing abilities in terms of dye penetration and bonding integrity at the sealer-dentine interface.* ***Materials and Methods****: Freshly extracted human first and second premolars were collected from the Department of Oral and Maxillofacial Surgery at Seema Dental College & Hospital, Uttarakhand. The roots were prepared, and the canals were obturated with ZOE and GuttaFlow 2 sealers respectively. SEM was employed to assess the microleakage and examine the quality of the sealer-dentine interface. Dye penetration was used as an indicator of microleakage. The extent of leakage and the presence of gaps at the sealer-dentine interface were evaluated and compared.* ***Results****: SEM analysis revealed that both ZOE and GuttaFlow 2 showed gaps between the sealer and the dentine walls, with a poorly defined, curved contact line at the sealer-dentine interface. However, the mean dye penetration for the ZOE group was significantly higher than that of the GuttaFlow 2 group, indicating greater microleakage in the ZOE-sealed specimens. In contrast, GuttaFlow 2 showed lower dye penetration, suggesting better sealing performance and less microleakage.* ***Conclusion****: GuttaFlow 2, shows better apical sealing ability when compared to ZOE.*

KEYWORDS: *root canal treatment, ZOE, GuttaFlow 2, Microleakage*

INTRODUCTION

Apical leakage in root-filled teeth is one of the most common causes of failure in endodontic treatment. Several factors contribute to this, including the choice of obturation technique, the presence or absence of a smear layer, and the properties of the root canal sealers used. Endodontic sealers play an important role in achieving a fluid-tight seal within the root canal system, including sealing the apical foramen and addressing canal irregularities and discrepancies between the dentinal walls and core filling material. By preventing leakage, sealers reduce the risk of residual bacteria migrating from the canal to the periapical tissues, which could lead to persistent infection and the development of periapical lesions.

An ideal root canal sealer should meet several essential criteria: providing an excellent seal, offering dimensional stability, having a slow setting time to ensure adequate working time, being insoluble in tissue fluids, demonstrating good adhesion to canal walls, and being biocompatible. Over the years, a variety of materials have been advocated for root canal obturation, including gutta-percha, silver points, and various sealers. Gutta-percha has long been considered the gold standard for root canal filling due to its favourable properties. However, the formation of interfaces between the sealer-gutta-percha cones and the sealer-

tooth structure, combined with the shrinkage of the sealer during setting, can create voids and lead to leakage.

Zinc oxide-eugenol (ZOE) sealers have been a standard choice in endodontics for many years. Despite their long history of use, ZOE-based sealers have shown limitations in their sealing ability and adhesion to dentin. In aqueous environments, ZOE sealers are more soluble, leading to the dissociation of zinc eugenolate into zinc hydroxide and eugenol, which further compromises their sealing properties. Interestingly, ZOE-based sealers exhibit less leakage when used in completely dried canals, although voids can still form, preventing a complete seal.

On the other hand, GuttaFlow 2 is a more recent sealer that combines the advantages of gutta-percha and a flowable sealer material. It can be used as both a sealer and obturating paste without the need for a solid master cone. GuttaFlow 2 contains finely ground gutta-percha particles (with a particle size of less than 30 µm) suspended in a matrix of polydimethylsiloxane, which gives it excellent flow properties at room temperature and enhances its ability to adapt to the canal walls and irregularities. These properties suggest that GuttaFlow 2 may offer improved sealing performance compared to traditional sealers such as ZOE.

The present study was undertaken to comparatively evaluate the sealing ability of Zinc Oxide Eugenol (ZOE) and GuttaFlow 2 using the dye penetration method. This study aims to assess the microleakage of these two endodontic sealers and compare their sealing performance, particularly with regard to their ability to prevent apical leakage and maintain a hermetic seal within the root canal system.

MATERIALS AND METHOD

1. Source of data: Extracted Human Permanent Teeth were collected from the Department of Oral & Maxillofacial Surgery, Seema Dental College & Hospital.

2. Study design: This study followed an ex-vivo comparative experimental design.

3. Place of study: Study was conducted in Department of Conservative Dentistry & Endodontics Seema Dental College & Hospital, Rishikesh.

4. Study period: The research was conducted over a period of 4 months.

MATERIALS USED

- Absorbent Paper Points (Dentsply, Ballaigues, Switzerland)
- Deionisized Distilled Water (Earthman Services Ltd, Dehradun)
- Disposable Syringe 5 ml (Dispo Van, HSMDL, Faridabad)
- Extracted Teeth (Freshly extracted intact and caries free premolars with mature apices)
- Endodontic Block (DentsplyMaillefer, Switzerland)

- Endo Access Bur (DentsplyMaillefer, Switzerland)
- Measuring Scale (Ajanta Scales Pvt Ltd, Ambala)
- Stainless Steel No. #10 - # 60 K-file(DentsplyMaillefer,Switzerland)
- 30-gauge Side Vent Opening Needle (DentsplySirona, Switzerland)
- Temporary Filling Material CavitTM G (3M, ESPE, Germany)
- Mythelene blue dye
- Endodontic sealers used

1. GuttaFlow 2
2. Zinc oxide Eugenol cement

LIST OF EQUIPEMENTS USED:

• SEM

• Glass Beakers (Jain Glass pvt Ltd, Pune)

• High Speed Alloy Grinder (Ray Foster, USA)

• High Speed Airotor (KavoKerr,Washington,DC)

• Incubator (Swastika India, AmbalaCantt)

• Radiovisiography (RVG) (DentsplySirona, New York, US)

• Ultrasonic Scaler (Electro Medical System, Switzerland)

• X- Smart Endomotor (DentsplySirona, New York, US)

- **INCLUSION CRITERIA:**

  1) Caries Free Teeth.

  2) Extracted Teeth that were Periodontally Compromised

  3) Teeth with Mature Root Apices.

- **EXCLUSION CRITERIA:**

  1) Carious Teeth

2) Fractured Teeth.

3) Restored Teeth.

4) Teeth with any Developmental Anomalies.

METHODOLOGY

Sample Size)N=198 Permanent Mandibular First And Second Premolar

↓

The CDC Guidelines For Infection Control In Dental Health-Care Setting 2003 was followed for the preparation of samples.

Teeth was scrubbed with detergent using ultrasonic cleaner to clean off visible blood and gross debris

↓

Samples was disinfected by immersion in 10 % Formalin for 7 days followed by autoclaving at 121ºC, 15 psi for 30 minutes

↓

Teeth was sectioned at cemento-enamel junction to maintain standardized length of 15 mm

↓

Access cavity was prepared followed by working length determination and biomechanical preparation

↓

Sample was obturated under 2 groups : Zinc Oxide Eugenol, GuttaFlow 2

↓

Coronal portion was covered with Glass Ionomer Cement

↓

Samples was dried for 2 minutes followed by application of nail varnish except on the apical 2 mm.

↓

The samples was immersed in 1% methylene blue at room temperature for 72hrs .

↓

Samples was buccolingually sectioned and examined under scanning electron microscope (SEM) to evaluate dye penetration

↓

The data was collected & subjected to statistical analysis using various tests.

SCORING OF THE VERTICAL DYE PENETRATION

The samples were scored as follows:

Score 1- 1-3 mm;

Score 2- 3-5 mm; and

Score 3- >5 mm.

STATASTICAL ANALYSIS

Data analysis:

The data obtained were subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS Version 23; Chicago Inc., IL, USA). Data comparison was done by applying specific statistical tests to find out the statistical significance of the comparisons.

To test for microleakage, Kolmogorov –Smirnov and Shapiro Wilk tests were performed to determine the normality of the data. Both the tests showed no significant differences and hence confirmed that the data obtained were normally distributed.

Variables were compared using mean values and standard deviation. The mean for different readings between the groups was compared using one-way analysis of variance (ANOVA), and the intercomparison between each group was done using Tukey's *post hoc* analysis. Chi square test was run to analyse significant differences between scores among groups. P lesser than 0.05 was considered statistically significant.

RESULTS

Results:

The current study was conducted with the purpose of evaluating the microleakage with various endodontic sealers. A total of 198 samples were analysed, with 99 in each of Group A and Group B

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TABLE 1: INTERGROUP COMPARISON OF ENDODONTIC SEALERS FOR MICROLEAKAGE

Materials	**GUTTA FLOW 2**	**ZOE**
Mean ± S.D	2.707 ± 1.248	9.734± 4.360
Minimum	1.10	3.45
Maximum	5.85	18.68
ANOVA Statistic	24.008	
Df	3	
P value	0.000*	

*=Significant;

NS –Not Significant

The highest microleakage was noted in ZOE (Group D) with a mean of 9.734± 4.360 , least was in the GUTTAFLOW 2 (Table 1 and Figure 1), which was significant at p=0.000

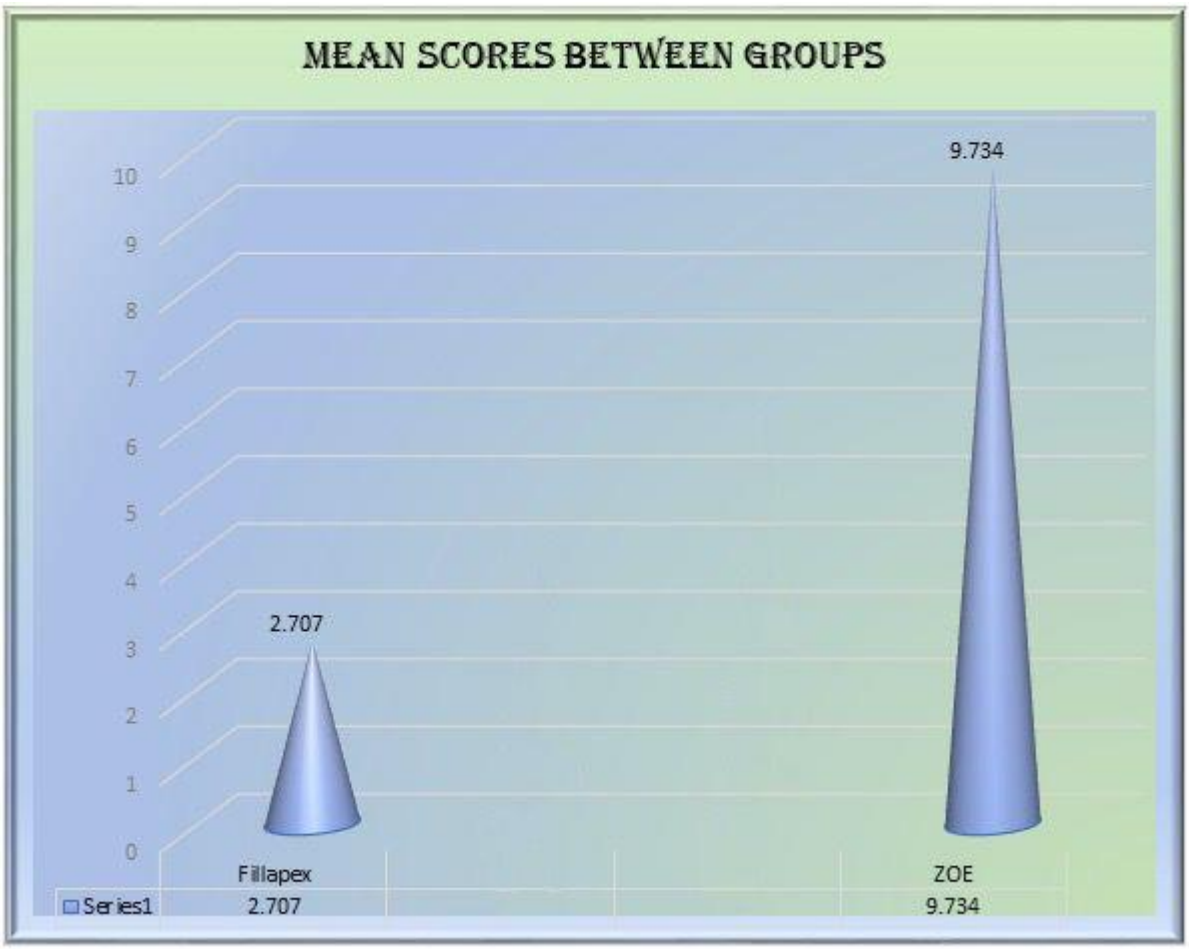

FIGURE 20: INTERGROUP COMPARISON OF ENDODONTIC SEALERS FOR MICROLEAKAGE

TABLE 2: POST HOC ANALYSIS OF SEALANTS FOR MICROLEAKAGE

Pairwise Comparisons	**Mean Difference**	**St.Error**	**Significance**
GuttaFlow 2 vs ZOE	-7.02988*	.89506	.000*

*=Significant; NS –Not Significant

One way Analysis of variance (ANOVA) with Post hoc tests were run to find any significant differences between the mean values of microleakage between sealants. Table 2 highlights mean difference. There was a statistically significant difference in microleakage between GuttaFlow 2 vs ZOE at p = 0.00.

TABLE 3: DISTRIBUTION OF SCORES AMONGST THE GROUPS

Groups	**Score 1 N (%)**	**Score 2 N (%)**	**Score 3 N (%)**	**Total N(%)**
Fillapex	13 (65.0)	4 (20.0)	3 (15.0)	20 (24.4)
ZOE	0 (0.0)	4 (19.0)	17 (81.0)	21 (25.6)
Total	18 (22.0)	31 (37.8)	33 (40.2)	82 (100)
Chi Square test	45.660			
Df	6			
P value	0.000*			

*=Significant; NS –Not Significant

When scores were compared between the groups, Score 1 was found to be highest in the GuttaFlow 2 group with 13 (65%) of the subjects presenting it. Score 3 was least in GuttaFlow 2 while it was of the greatest percentage in ZOE group with 17(81.0%) of the sample demonstrating it. This was significant at p = 0.000 as seen in Table 3.

DISCUSSION

Successful endodontic therapy is dependent on a 3D obturation of root canal which minimises microleakage which means it prevents passage of bacteria and it's by products, fluids and chemical substances between the root structure and various filling materials.

The most commonly used core filling material is gutta-percha, which can be reasonably adjusted to the root canal walls. However, due to canal irregularities and the size of the dentinal tubules, a root canal sealer is also essential. A root canal sealer will not only assist in filling irregular spaces but also in enhancing the seal during compaction and penetration into small, normally inaccessible areas, i.e., the dentinal tubules.

The study which support the present study was conducted by Elayouti and Acheleithner, [13] this experimental study evaluated the homogeneity and adaption of a GuttaFlow 2 to root canal walls and found that GuttaFlow 2 completely filled the prepared root canal but small voids were frequently present within the core of the filling material.

Scanning electronic microscopic methodology evaluates the sealing ability and adhesiveness of the sealer to dentine walls. According to SEM findings in this research, the samples of Group A obturated with ZnO-oxide eugenol/ gutta-percha using a cold lateral obturation technique. Gaps were often found between sealers and dentine walls with an unclear and curved contact line in the sealer-dentine interface. In GuttaFlow 2 i.e. Group B showed extremely good adhesion to the dentine walls with the tight sealer dentin interface, no spaces or ruptures between the sealer and canal walls.

GuttaFlow2 showed a smooth contact line on the sealer-dentine interface without gaps, and may be with massive penetration of the sealers inside the tubules. The findings obtained during SEM observation in this research suggest that the physical integrity of the sealer matrix is also important.

As a resin-based sealer GuttaFlow 2 has a homogeneous structure with particles of gutta-percha and appears to fill the dentinal tubules well with extremely good adhesion to gutta-percha cones. Zinc oxide eugenol sealer composed of mainly zinc oxide and appears porous after mixing with eugenol. This could be the reason for a lower adhesion to gutta-percha and root dentinal wall when compared to GuttaFlow 2.

The GuttaFlow 2 does not create a chemical bond with in the internal tooth structure, but its apical seal is greater than Zno-eugenol/gutta-percha using cold lateral obturation.

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