Research Article

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A Comparative Study on Polymicrobial Coronal Leakage with Two Different Nano Restorative Materials In Endodontically Treated Teeth

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ABSTRACT

Aim: The main objective of this study was to assess the coronal microleakage using polymicrobial marker when the access cavities were restored with GC Fuji IX, Filtek ™ Z350 XT, Filtek ™ Z350 XT and Ketac ™ N100.

Materials and Methodology: Access opening of single rooted teeth were done and clean and shaped using step down method. All teeth were sectioned horizontally to 4mm thickness and were randomly grouped to restore with their respective restorative materials (nano-composite, conventional composite, nano-glass-inomer cement and conventional glass inomer cement). All the samples were artificially aged by thermocycling and were placed in their respective ependroff tubes over which bacteria inoculated brain heart infusion broth was placed. These tubes were placed in sterile bottles containing sterile broth and observed for turbidity.

Results: Kruskal-Wallis one way ANOVA test and Chi-square test using SPSS 20.0 version was used to statistically analyze the sealing ability of the four restorative materials.

Conclusion: There was no significant difference among the four groups. Nanocomposite (Filtek ™ Z350 XT) showed better sealing ability than other three groups. Least sealing ability was seen with group restored with conventional glass ionomer cement.

Keywords: Coronal microleakage, polymicrobial marker, restorative materials.

INTRODUCTION

The concept of coronal leakage having an effect on the outcome of root canal treatment has been known for nearly 90 years. The most common area for failure of root canal therapy is due to apical percolation or microleakage due to an inadequate apical and coronal seal allowing periapical fluids, proteins, and bacteria access through the root canal causing an inflammatory reaction which results in radiographic or clinical signs of failure of root canal therapy. (1)

The apical seal is adversely affected if coronal seal is lost or becomes defective because a well-sealing coronal restoration is necessary to protect the root filling from the influence of the oral environment. (2,3) It was found that highest success rate (81%) was found in the teeth diagnosed with good endodontics and good restorations and the success rate dropped to 10% to 71% in teeth with good endodontics and poor restorations. (4)

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Good coronal restoration resulted in significant healing of periradicular inflammation as compared to well obturated root canals. (5) The ultimate objective for successful root canal treatment is to achieve a fluid tight impervious seal at the coronal and apical ends. (6)

Achieving a micromechanical and biomechanical bond between the restoration and tooth is considered effective and a standard procedure in clinical practice instead of using simply lathe-cut low copper amalgam or silicate cement to restore access cavities to reduce the interface. (7)

The objective of the present in vitro study is to compare the sealing ability of the most innovative restorative materials Conventional Glass Ionomer Cements, Nano GIC, Microfilled Composites, Nanofilled Composites using bacteria as a method of studying microleakage.

MATERIALS AND METHODS

A total of 60 freshly extracted, intact, human mandibular premolars were used in this study **(fig.1).** The teeth were immersed in 3%Sodium hypochlorite (Vishal dentocare, Ahemedabad, India) for 15 min to remove organic material from the root surfaces and stored in saline solution until the study was started.

Using Endoaccess bur#3(Dentsply, USA), access opening was done in all teeth and patency was checked with k-file 15(Mani INC, Japan). The coronal third of tooth was enlarged with Gates glidden drill #4(Mani INC, Japan) and irrigated with alternate regimen of irrigants sodium hypochlorite, EDTA (Pulpdent solution, Water Town, USA) and finally rinsed with saline(Claris Life Sciences,Ahmedabad,India). The cusps of all teeth were flattened and the coronal section of 4mm **(fig.5)**was used for the study and it was separated from root part of the tooth by sectioning horizontally with diamond disk. (8,9) All the samples were prepared such that they have through and through channel and were dried using cotton absorbent points. All samples were coated with three layers of nail varnish.

The samples were divided into four groups of each having fifteen teeth (n=15) and each group samples were restored with their respective restorative material according to the manufacturer's instructions. In this study only coronal section was taken so as to see how long only the restorative material can seal the margins from coronal percolation of the fluids without having any influence of obturating material like gutta-percha and sealer. The restorative materials used were GC High strength posterior glass ionomer powder(GC Fuji IX,GC corporation, Tokyo, JAPAN), Microcomposite (3M ESPE Filtek ™ Z350 XT, St.Paul, USA), Nanocomposite(3M ESPE Filtek ™ Z350 XT, St.Paul, USA) and Nanoionomer(3M ESPE Ketac ™ N100, St.Paul, USA) (fig.2) and according to manufacturer instructions cured using QTH light curing device(Astralis 7, Vivadent, Liechtenstein) for 40seconds with the intensity of 400mv/cm^2.**(fig.4)**

Group I Access cavities were sealed with GC High strength posterior glass ionomer powder + liquid (Fuji IX)

Group II Access cavities were sealed with 3M ESPE Scotch bond multipurpose etchant + 3M ESPE Adaper single bond adhesive + 3M ESPE Filtek ™ Z250Microcomposite

Group III Access cavities were sealed with 3M ESPE nanoionomer primer + 3M ESPE Ketac ™ N100,lightcuring nano restorative material

Group IV Access cavities were sealed with 3M ESPE Scotch bond multipurpose etchant + 3M ESPE Adaper single bond adhesive + 3M ESPE Filtek ™ Z350 XT Nanocomposite. **(fig.6)**

NEGATIVE CONTROL:

Sterile glass bottles containing sterile broth was used as negative control. If turbidity was seen in this bottle, it infers us that broth was contaminated.

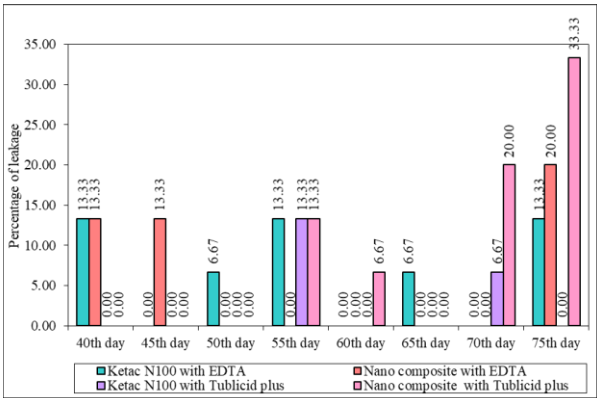
To artificially age teeth, all samples were subjected to thermocycling (150 cycles at -5ºC and 55 ºC for dwell time of 30 sec). (10)**(fig.7)**

The samples were placed in an ependroff tubes and sealed with acrylic and feviquick such that small part of the tooth was suspended out of the ependroff tubes to be in contact with the sterile broth in a glass bottles of 100cc volume. The

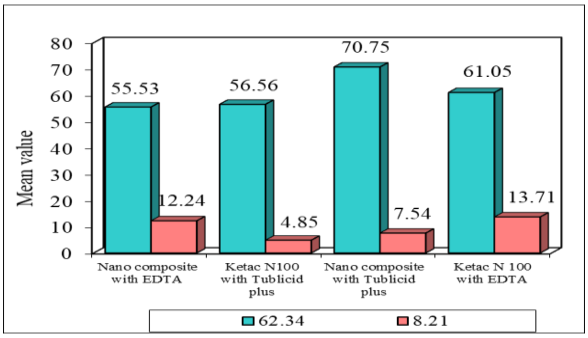
Table 1: Mean number of days at which the leakage occurred in each group.

Groups	Mean	Std.Dev.
Conventional glass ionomer	51.67	8.31
Micro composite (Z250)	53.11	6.51
Ketac N100	58.06	5.16
Nano composite	61.05	13.71
Total	56.45	9.90
F-value	1.8817	
P-value	0.1532	
Pair wise comparison of groups by Tukeys multiple post hoc procedure		
CGI vs MC	0.9905	
CGI vs KN	0.5726	
CGI vs NC	0.1979	
MC vs KN	0.7111	
MC vs NC	0.2699	
KN vs NC	0.9065	

CGI : Posterior high strength glass ionomer (Fuji type IX)
MC : Microcomposite (FiltekTM Z250)
KN : Nano ionomer (KetacTM N100)
NC : Nano composite (FiltekTM Z350)



Graph 1: Comparison of time points with respect to leakage in Conventional glass ionomer, Micro composite (Z250), Ketac N100 and Nano composite.



Graph 2: Comparison of mean number of days at which the leakage occurred in each group.

Fig 1: Freshly extracted human mandibular premolars.

Fig 2: The four restorative materials.

Fig 3: Armamentarium.

Fig 4: CU-100A light curing unit.

Fig 5: Coronal section of 4mm length.

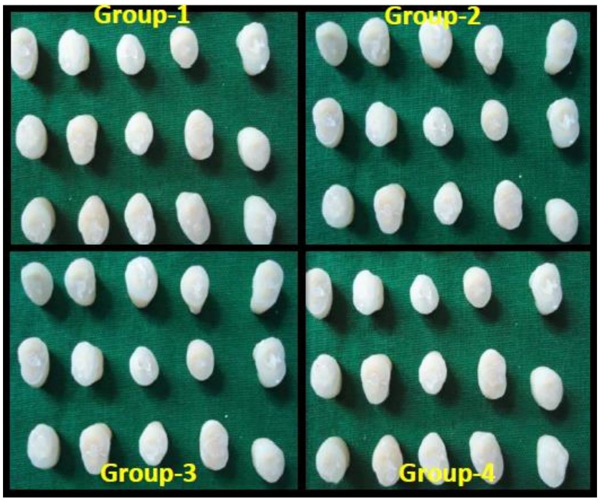


Fig 6: Restored samples.

Fig 7: Thermocycling restored samples.

Fig 8: Samples in incubator.

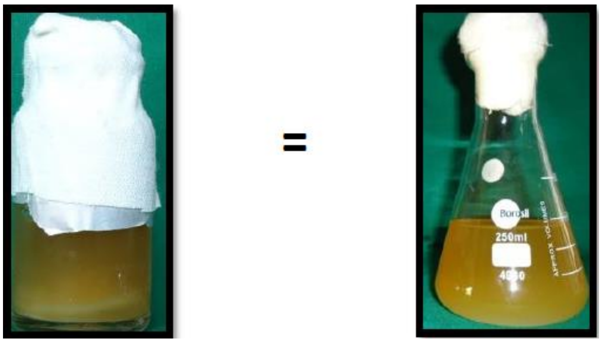


Fig 9: Turbidity in lower chamber similar to bacteria incubated brain heart infusion broth.

bacteria were brought from Chandigarh, Enterococcus faecalis was MTCC (Microbial Type Culture Center) no.439 and Candida albicans was MTCC no.227 and were cultured in brain heart infusion broth.

Ependroff tubes with samples and glass bottles were autoclaved before subjecting them to microbiological study. Brain heart infusion broth inoculated with Enterococcus faecalis, Candida albicans for 24hrs and placed in the ependroff tubes and sterile brain heart infusion broth **(fig.9)** was placed in glass bottles and sealed with aluminium foil and cotton tape roll to make them free from contamination through air. All the samples are colour coded and placed in an incubator at 37 ºC.**(fig.8)** For every 5days the brain heart infusion broth inoculated with Enterococcus faecalis, Candida albicans in ependroff tubes was replaced with fresh 24hrs inoculated broth.

Upto 90days, the samples were observed for turbidity which was an indication for occurrence of microlekage. The day on which leakage occurred was noted. Results were statistically analyzed by kruskal-walis ANOVA test and Chi-square test using SPSS 20.0 version.

RESULTS

Kruskal-Wallis one way ANOVA test and Chi-square test was done to statistically analyze the sealing ability of different restorative materials. Nanocomposite 3M ESPE Filtek ™ Z350 has better sealing ability than the other three restorative materials and least sealing capacity was seen with GC High strength posterior glass ionomer (graph 1,2 and table1).

DISCUSSION

Microleakage is defined as clinically undetectable passage of bacteria, fluids, molecules or ions between a cavity wall and the restorative material applied to it. (11) The integrity and durability of the marginal seal has always been of prime concern in the investigation of the performance of a dental restorative material. Clinically microleakage can be identified as a dynamic phenomenon.

Pulpal and periradicular diseases develop when micro-organisms and/or their by-products contaminate these tissues. The root canal treatment intended to treat these conditions to remove irritants from the root canal system and obturate the cleaned and shaped system to prevent future recontamination of sealed root canals.

Both in vitro and in vivo investigations show that post-endodontic coronal microleakage can allow bacterial penetration in the filled root canal system, causing recontamination leading to failure of treatment.

The quality of the coronal seal is just as important as the quality of the root canal filling for periapical health. (12) In the absence of an intact coronal seal, re-contamination of the entire length of filled root canal by bacteria or their by-products may occur. (13, 14) The prognosis of root-filled teeth can be improved by efficient coronal seal. (15)

Today much more attention has been focused on procedures performed to achieve an effective coronal seal soon after the completion of root canal therapy. (16)

The nature of the penetrating materials like radioisotopes, liquid dyes, fluid filtration, and electro-chemical were not accurate because of differences in molecular size, viscosity, surface tension, or discoloration which influences the penetration capability and detection. (17-20) Using bacteria leakage tracer will provide more biologically significant and clinically relevant information than the dye penetration method. (21-23)The main disadvantage is the bacterial studies have been qualitative rather than quantitative. (24,25) It was found that there is a real lack of technique standardization, as even when one and the same methodology is used, small variations may be included, which were able to interfere in the final outcome. Enterococcus faecalis, Candida albicans were most commonly isolated microbes in endodontic failure cases and so used in current study. (8)

In this present study, access opening of single rooted teeth was done and clean and shaped using step down method. The diameter of the orifice opening of all teeth was standardized. All teeth were sectioned horizontally to have 4mm length and were restored with high strength posterior glass ionomer cement, microfilled Filtek Z250 composite, Ketac N100, nanocomposite Filtek Z350 XT. After thermocycling, microleakage of these restorative materials was measured by using polymicrobial marker (Enterococcus faecalis, Candida albicans) which were inoculated in brain heart infusion broth. This microleakage study was carried out in a split chamber model in which the broth was changed in the upper chamber for every 5days and observed for turbidity in the lower chamber for 90days. The samples which showed turbidity visually were subjected to culture sensitive test and found that the turbidity was due to the same microbes.

All the groups showed leakage within 75days with nanocomposite showing better performance compared with other restorative materials but there was no significant difference among all the groups which was evaluated by kruskal walis ANOVA test and chi-square test.

In my present study Fuji IX, Filtek Z250(micro-composite), Ketac N100(nano glass ionomer), Filtek Z350XT(nano composite) were used for evaluating the mean number of days at which microleakage has occurred.

In a study done by Vesna Miletic moderate microleakage with Filtek™ Z250 may be because of the particle size which improves the flow of material due to improved viscosity and hence better adaptability and also water sorption of these materials compensates for polymerization shrinkage, which is attributed to less filler content.(26)

In a study done by Goreseta et al nanofilled resin modified glass ionomer cement (Ketac N100) showed least microleakage compared to conventional glass ionomer cement.(27)

The mean microleakage for Filtek Z350 which was similar to Filtek Z350XT showed least microleakage which proves that nanocomposites were both stronger and more effective at preventing secondary decay. It provides a steady release of calcium and phosphate ions that are essential to the long-term success according to study done by Korsali et al and Deepali s.(10)

On comparision it was observed that Filtek Z350XT, the nanocomposite displayed minimum microleakage. On comparision it was observed that Filtek Z350XT, the nanocomposite displayed minimum microleakage which is in accordance with the study done by Kanika Verma Gupta et al where they compared microleakage of the restorative materials.(7)

CONCLUSION

From this present study, it may be concluded that no material can replace lost tooth structure. Even the advancing nanotechnology introduces nanofiller particles to strengthen and reduce the interface between tooth and restorative material in addition to the adhesive systems that bond to the tooth showing monoblock concept and different obturating techniques, materials and sealers, none of them could resist microleakage. Immediately after completion of endodontic treatment, definitive treatment like placing crowns to large extent may prevent seepage of oral fluid having bacteria along the tooth-restoration interface and also reinforces the tooth to distribute occlusal forces evenly which would otherwise compromise the success of the endodontic treatment.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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