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COMPARISON OF APICAL MICROLEAKAGE IN IMMEDIATE AND DELAYED POST SPACE PREPARATION USING THREE DIFFERENT ROOT CANAL SEALERS : AN IN VITRO STUDY

Dental Science

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ABSTRACT

Introduction: This study compared the effect of immediate versus delayed post space preparation on the apical seal using three different sealers.
Materials and Methods: Seventy single rooted teeth were biomechanically prepared and obturated with gutta-percha and 3 sealers: AH Plus, MTA and BioRoot RCS sealer. Teeth were divided randomly into eight groups, post spaces were prepared using Gates Glidden drills and peso reamers immediately for group I, III and V. For groups II, IV and VI prepared after storage of the specimens in 100% humidity for one week. Groups VII and VIII were control groups. The samples were kept in methylene blue dye, centrifuged at 3000 rpm for 3 min sectioned and then measured under stereomicroscope for apical leakage.
Results: The results of this study showed that apical microleakage was observed in all the groups.
Conclusion: Less leakage is seen when post space is prepared immediately

KEYWORDS

AH Plus; MTA; BioRoot RCS; microleakage

INTRODUCTION

Root canal treated teeth often lack sufficient support for a permanent restoration. Thus, these teeth often may need the use of an intracanal post for retention of the core[1]. In the last few decades, various prefabricated posts systems have been developed. Post design is important, because it may have an influence on the longevity of the tooth. Various factors which influence post/dowel selection: Amount of coronal tooth structure, tooth anatomy, position of the tooth in the arch, root length, root width, canal configuration, functional requirements of the tooth, torquing force, stresses, development of hydrostatic pressure, post design, post material, material compatibility, bonding capability, core retention, retrievability, esthetics and crown material[2].

A hermetic apical seal is necessary to ensure a successful root canal treatment; it is important not to disrupt the integrity of the same during post-space preparation.

Several studies have shown varying results on the effect of timing of post-space preparation following obturation on the apical leakage. The needed post-space may be prepared either immediately after completing the obturation of the pulp space or after 1 week.

Metzger et al. demonstrated that the sealing is proportional to the length of the remaining obturated material. Fan et al. and Karapanou et al. suggested that delayed post-space preparation resulted in greater leakage using zinc oxide eugenol based sealer[1]. various studies (Bourgeois RS et al; 1981, Zmener O; 1980, Madison S et al; 1984, and Schnell FJ et al; 1978) have shown that there is no difference in the leakage of the root canal filling material when the post space is prepared immediately after completing endodontic therapy. Bourgeois and Lemon (1981) found no difference in the immediate and one week canal preparation when 4 mm of gutta-percha was retained. Zmener (1980) found no difference in dye penetration between gutta-percha removal after 5 minutes and 48 hours. Dickey et al (1982) reported contrasting results they found significantly greater leakage with immediate gutta-percha removal. Portell et al (1982) found that delayed gutta-percha removal (after 2 weeks) caused significantly more leakage than immediate removal when only 3 mm of gutta-percha was retained apically[2].

The root canal sealers functions as binding agent to cement the well fitted primary cone in to a canal, a filler for the discrepancies between the cone and the canal walls and a lubricant to fabricate the seating of the primary cone in to the canal.

Sealers generally used for root canal treatment are categorized as:-

Zinc oxide eugenol based – All ZOE based sealers have extended working time but set faster in the tooth than on the slab because of increased body temperature and humidity. Zinc oxide eugenol has the disadvantage, however, of being decomposed by water through a continuous loss of eugenol. This makes ZOE a weak, unstable material and precludes its use in bulk, such as retrofillings placed apically through a surgical approach. Examples of Zinc oxide eugenol based sealers are– rickert's sealer, roth's sealer, kerr pulp sealer and tubliseal.
Resin based –Resin based sealers adapt closely to canal walls because of good adhesion properties. Examples of resin based sealers are – Diaket, AH-26 and AH-Plus sealer.

Calcium hydroxide based – The two important reasons for using calcium hydroxide as a root-filling material are:
1- Stimulation of the periapical tissues in order to maintain health or promote healing.
2- For its antimicrobial effects.

Examples of calcium hydroxide based sealers are - CRCS (Calcibiotic root canal sealer), seal apex and apexit.

Glass ionomer based – Glass-ionomer root sealer is commonly used because of its chemical bonding and favorable physical characterstics when bonding to dentin. Example of glass ionomer based sealer is- Ketac-Endo.

Based on different compositions, three different sealers were used in this study: AH plus, MTA and BioRoot RCS to seek comparative evaluation of apical microleakage.

Materials and methodology

This was an in-vitro study which was conducted in the department of Conservative Dentistry and Endodontics of School of Dental Sciences, Sharda University, Greater Noida. The stereomicroscope analysis was done at SPECTRO ANALYTICAL LAB, Greater Noida.

MATERIALS:-

- Gutta-percha cones (Dentsply Millefer)
- 0.9% Saline
- 5.25% Sodium hypochlorite (NaOCl)
- Paper points (Meta Biomed)
- 2% Methylene blue dye
- Storage medium-10% neutral buffered formalin
- Resin-based (AH Plus) (Dentsply)

- MTA
- Tricalcium silicate- based BioRoot RCS
- Permanent marker pen

METHOD:-

SAMPLE SELECTION AND SAMPLE SIZE:-

70 extracted single rooted human mandibular premolar (10 in each group & 5 in each control group)

Criteria For Selection:

Inclusion Criteria:-

- Freshly extracted human mandibular premolar.
- Single rooted teeth with single straight canal.
- Teeth with closed apex.
- Teeth with more than one canal.
- Teeth with root caries.
- Teeth with more than one canal.
- Teeth with root caries.

EXCLUSION CRITERIA:-

- Dilacerated / tooth with anomalies
- Teeth with more than one canal.
- Teeth with root caries
- Teeth with open apex

The teeth were visually inspected using magnifying loupes according to inclusion and exclusion criteria and selected teeth were stored in 10% neutral buffered formalin until use.

SAMPLE PREPARATION:-

All samples were decoronated at C.E.J (to attain standardized root length of 18mm) using diamond disc. Canal length was assessed by the help of 10 k file (Mani) and radiograph was taken. Root canals were instrumented at estimated working length with hand protapers using step-down technique till F3. Standard irrigation protocol was followed. Samples were assigned to experimental groups.

SAMPLE GROUPING:-

Sample size: 70 samples (10 in each group & 5 in each control group)
Size of each group:

Group1:-Obturation was done with gutta–percha cone & AH Plus sealer, followed by immediate post space preparation.

Group2:- Obturation was done with gutta-percha cone & AH Plus sealer, postspace was prepared 1 week after obturation.

Group3:-Obturation with gutta-percha cone & MTA sealer, followed by immediate postspace preparation.

Group4:-Obturation was done with gutta-percha cone & MTA sealer, postspace was prepared 1 week after obturation.

Group5:- Obturation was done with gutta-percha cone & BioRoot RCS sealer, followed by immediate postspace preparation.

Group6:- Obturation was done with gutta-percha cone & BioRoot RCS sealer, postspace was prepared 1 week after obturation.

Control groups:-

Group7:- Obturation was done without sealer (positive control).

Group 8:- Oobturation, gutta-percha cone & sealer were not used (negative control).

METHODOLOGY:-

The canal sealers were mixed & handled according to the manufacturer's instructions. The root canals obturation was done using gutta-percha cone. Radiographs were taken to assess the obturation.

Surfaces & coronal openings of all roots were coated with 2 layers of sticky wax except for apical 3 mm. Samples used as positive & negative controls were instrumented, 5 positive control roots were filled with a loosely fitted gutta-percha cone & 5 negative control remained unobturated. Apical foramen of the positive control was completely covered with two layers of sticky wax, except for the apical 3 mm, whereas that of the negative control was completely covered with two layers of sticky wax.

Post space was prepared immediately in Groups I, III and V with Peeso reamers from size 1 to 4 at 4000 rpm to a depth leaving 5-6 mm of gutta-percha apically.

In Groups II, IV, and VI the samples were stored in incubator at 37°C for 1 week, and the post spaces was prepared with Peeso reamers from size 1 to 4 at 4000 rpm to a depth leaving 5-6 mm gutta-percha apically.

Dye penetration

Samples were placed in 2% methylene blue dye and centrifuged at 3000 rpm for 3 min at room temperature. Samples were removed from dye and washed under running tap water for half an hour to remove dye on external root surface.

Method of microscopy

Samples were finally subjected for vertical sectioning. Samples were then assessed under stereomicroscope by 2 observers for unbiased results. With the help of photomicrographs obtain, linear measurement of dye penetration was noted from apical to coronal direction at 10 magnification with a calibrated ocular eyepiece & the highest value among samples was recorded. Within each group scoring Criteria to view the greatest extent of dye penetration in root canal walls were evaluated.

Scoring criteria for penetration depth of sealer into dentinal tubules[3]

Score 0: Dye not visible on the root canal walls

Score 1: Dye visible on the root canal walls

Score 2: Dye infiltrations up to half of the distance longitudinally

Score 3: Dye infiltrations more than half of the root surface longitudinally.

To remove any inter observer bias, extent of dye penetration was evaluated by 2 independent observers, who was unaware of materials & methods used in study but was instructed about method of measuring & recording the extent of dye penetration.

RESULTS

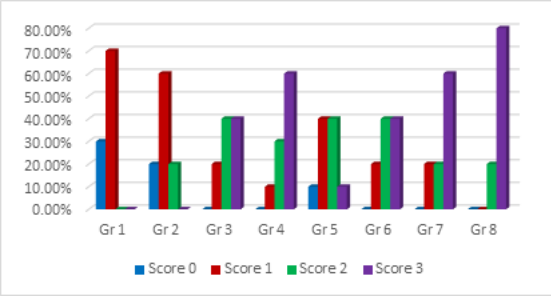
The results of this study showed that apical micro leakage was observed in all the groups. The specimen in Group 1 (AH Plus – immediate post space preparation) showed minimal leakage and specimen in Group 6 (BioRoot RCS-delayed post space preparation) showed a maximum leakage. However apical microleakage was less in immediate post space preparation groups than when it was compared with delayed post space preparation groups.

Table 1:

Group			Microleakage score				Total
			Score 0	Score 1	Score 2	Score 3	
Gr 1	AH plus Immediate	n	3	7	0	0	10
		%	30.0%	70.0%	0.0%	0.0%	100.0%
Gr 2	AH plus Delayed	n	2	6	2	0	10
		%	20.0%	60.0%	20.0%	0.0%	100.0%
Gr 3	MTA Immediate	n	0	2	4	4	10
		%	0.0%	20.0%	40.0%	40.0%	100.0%
Gr 4	MTA Delayed	n	0	1	3	6	10
		%	0.0%	10.0%	30.0%	60.0%	100.0%
Gr 5	Bio Root RCS Immediate	n	1	4	4	1	10
		%	10.0%	40.0%	40.0%	10.0%	100.0%
Gr 6	Bio Root RCS Delayed	n	0	2	4	4	10
		%	0.0%	20.0%	40.0%	40.0%	100.0%
Gr 7	Positive control	n	0	1	1	3	5
		%	0.0%	20.0%	20.0%	60.0%	100.0%
Gr 8	Negative control	n	0	0	1	4	5
		%	0.0%	0.0%	20.0%	80.0%	100.0%
Total		n	6	23	19	22	70
		%	8.6%	32.9%	27.1%	31.4%	100.0%
Pavalue			0.004, S				

Frequency distribution of different microleakage scores among different groups was compared using Chi square test and the differences were found to be statistically significant. Among AH plus groups (both delayed and immediate) Score 0 & Score1 were found to

be more commonly present as compared to other groups. While all the remaining groups showed a significantly higher proportions of Score 2 & Score 3.



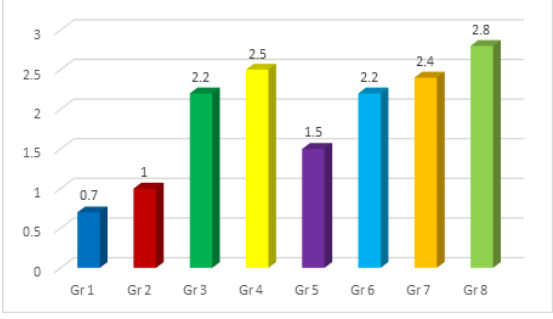
Graph 1:- Distribution of Microleakage scores among study groups

Table 2:

Group	N	Mean	Std. Deviation	Minimum	Maximum
Gr 1	10	0.70	0.48	0.00	1.00
Gr 2	10	1.00	0.67	0.00	2.00
Gr 3	10	2.20	0.79	1.00	3.00
Gr 4	10	2.50	0.71	1.00	3.00
Gr 5	10	1.50	0.85	0.00	3.00
Gr 6	10	2.20	0.79	1.00	3.00
Gr 7	5	2.40	0.89	1.00	3.00
Gr 8	5	2.80	0.45	2.00	3.00
Total	60	1.81	0.98	0.00	3.00
Overall P value[b]		<0.0001, S			
Post hoc pairwise comparison[c]	Gr 3, Gr 4, Gr 6 > Gr 5 > Gr 1 Gr 3, Gr 4, Gr 6 > Gr 2 Gr 7, Gr 8 > Gr 5 > Gr 1, Gr 2				

Inferential statistics regarding intergroup comparison of Mean Microleakage scores was done using Kruskal Wallis test. Overall, the differences in mean microleakage scores were found to be significantly different among study groups. Post hoc pairwise comparison was done using Mann Whitney U test and it was found that Mean Microleakage score of Gr 1 (AH plus Immediate) was significantly less than that among Gr 5 (BioRoot RCS Immediate)which was further significantly less than that Gr 3,4, 6, 7 & 8. Also, Mean Microleakage score of Gr 2 (AH plus Delayed) was significantly less than that among Gr 3, 4, 6, 7 & 8.

Graph 2:- Mean Microleakage scores



DISCUSSION

The microorganisms and toxins in the root canal are prevented from crossing into periradicular tissues by the root canal filling materials.[4] A large percentage of failures in endodontic therapy is attributed to the difficulty in obliterating accessory canals, fins, anastomoses, apical deltas, and irregularities of the root canal and failure to get an adequate apical seal.[5]

Although gutta-percha is a gold standard root canal filling material, it fails to provide a three-dimensional seal. Hence, sealers are used with gutta-percha to seal the root canal system into the inaccessible areas.[6] The integrity of apical seal is proportional to the amount of remaining filling material. It has been reported in studies that 4–5 mm of apical gutta-percha should be retained apically which may provide adequate apical seal.[7,8]

A hermetic apical seal is necessary to ensure a successful endodontic treatment. It is important not to disturb the integrity of the same. Endodontically treated teeth often lack sufficient support for a permanent restoration. So, the use of an intracanal post for retention of the core has been proposed. Various studies have been conducted shown varying results on the effect of timing of post space preparation following obturation on the apical leakage. The required post space preparation may be prepared either immediately after completing the obturation of the pulp space or after one week time interval. This study not just ensured the selection of sealers for obturation but also helped for deciding the correct time for post space preparation for a successful outcome of endodontic treatment.

Delayed post space preparation done using AH Plus sealer showed dye penetration which was significantly more than immediate post space preparation; this was in accordance with the results of Goodacre CJ et al.[9] A study by Ørstavik et al. concluded that all epoxy-based materials show some expansion after setting.[10] AH Plus expanded up to 0.4% after 4 weeks and depicted a slight but continuous expansion up to 1.2% during the next 4-week period. These dimensional changes of the material upon setting could be the possible reason for minimal apical leakage.

BioRoot RCS, the new silicon-based sealer, presents promising physical, chemical, and biological properties. Although there are doubts regarding the filling capability of this filling material, which seems to be deficient because of the voids present in the filling mass, its adequate marginal sealing capacity can be explained by the expansion property this tricalcium silicate- based root canal sealer during polymerization.

Borges et al. evidenced that the solubility of MTA was statistically higher than that of AH Plus even though both materials fulfill the ANSI/ADA, according to which a root canal sealer should not present solubility higher than 3%.[11] Fabricio Guerrero et al. evidenced that MTA has better porosity properties than BioRoot RCS.[12]

CONCLUSION

Within the limitations of this study, the following conclusions can be drawn:

The quality of the root canal filling is important to maintain the integrity of the apical seal during post space preparation. According to the results delayed post space preparation causes more apical microleakage.

The results of the present study showed that microleakage of AH26 was significantly less compared to MTA and BioRoot RCS.

Further investigations are required to predict the outcome of the study.

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