

Comparison of microleakage in three different retrograde cavity preparations with Mineral Trioxide Aggregate as filling material

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ABSTRACT

Background: The apical seal is the single most important factor in determining the success of surgical endodontics, the aim of this study was to compare the sealing ability of Mineral Trioxide Aggregate in three different cavity designs.

Materials and Methods: Thirty extracted human single-rooted teeth were divided into three groups of ten teeth per group, a retrograde cavity preparation was carried out using a low speed handpiece and round bur with parallel walls in the first group, ultrasonic retrotip and unit in the second group and a low speed handpiece with a carbide inverted cone bur with undercuts in the third group, all the cavities were filled with MTA. microleakage was measured by dye penetration technique using methylene blue.

Results: the third group showed the best sealing ability, followed by the first group while the second group showed the least sealing ability, the differences were statistically significant ($p < 0.05$).

Conclusion: retrograde cavities prepared with inverted cone bur and low speed handpiece showed the best sealing ability probably due to the increased surface area between the walls of the cavity and the filling material.

Keywords: Microleakage, retrograde cavity preparation, MTA. (J Bagh Coll Dentistry 2010;22(3):34-38).

INTRODUCTION

Endodontics is that branch of dentistry concerned with the diagnosis and treatment of diseases and injuries of the pulp and periapical tissues.

The objective of endodontic treatment is to render the affected tooth biologically acceptable (symptom-free), functional and without diagnosable pathology⁽¹⁾, and this is achieved by removal of irritants through chemomechanical debridement, total obturation of the root canal system and prevention of recontamination⁽³⁾, but this objective is not always attained as failures may arise due to inadequate control of infection, inadequate instrumentation and obturation, missed canals and coronal leakage⁽⁴⁾.

Failure of root canal treatment results in periapical infection, chronic infections may lead to the development of periapical granulomas or cysts.

Management of endodontic failure is by retreatment by conventional endodontics (which is the preferred treatment)^(3,4), extraction of the involved tooth or by endodontic surgery.

Endodontic surgery also termed surgical endodontics, periradicular surgery or apicectomy consists of reflection of a mucoperiosteal flap, root-end resection, curettage of the periapical pathology and provision of apical seal which may be done through preparation of a small cavity at the cut end of the root using a right angled microhandpiece and bur and the application of a suitable filling material.

The American Association of Endodontists defines apicectomy as; the excision of the apical portion of the tooth root and the attached soft tissue during periradicular surgery⁽⁶⁾.

It is believed that the first cases of endodontic surgery were performed by Abu Al-Qasim Al-Zahrawi (936-1013 A.D.) who is also known by his Latin name Abulcasis. Some researchers, however, claim Claude Martin as the inventor of root-end resection in 1881, and root-end resection with retrograde cavity preparation and filling with amalgam was documented in the 1890's, in 1930's indications for endodontic surgery were first proposed⁽⁴⁾, but the rationale for performing endodontic surgery has changed considerably over the past years.

The main indications for surgical endodontics are; when inability to eliminate pathological process with conventional endodontic treatment, when it is impossible to debride and fill the entire root canal due to severe curvature of the root, calcified canals...etc. and to correct a conventional treatment failure or procedural accidents. While

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the contraindications include; when non-surgical treatment would provide an equivalent results, when medical status of the patient contraindicates surgical treatment, anatomical considerations would impose risk to the patient and when the procedure is not within the capabilities of the surgeon⁽¹⁾.

In recent years there have been important innovations in the practice of endodontic surgery, these included; advances in imaging diagnosis, surgical technique, visibility of the surgical field in particular the introduction of the surgical microscope providing better and sharper visualization, introduction of laser, guided tissue regeneration and advances in retrograde filling materials^(5,9).

Among the advances was the use of ultrasound in root-end cavity preparation which constituted an important step forward in periapical surgery. The first report of the use of ultrasound in surgical endodontics was by Richman⁽⁷⁾, and Bertrand presented a modified cavitron for root-end cavity preparation⁽⁸⁾.

The main reported advantages of the use of ultrasound include; more conservative preparation in long axis of the root with greater depth while decreasing the amount of debris, sufficient residual thickness and stability of the root walls, small resection angle, perforations are avoided also time saving^(3,10).

Mineral Trioxide Aggregate (MTA) is a material developed in Loma Linda university, USA and represent a significant improvement over other materials used as a root-end filling materials, it is the first restorative material that allows for the overgrowth of cementum and it may facilitate the regeneration of periodontal ligament⁽¹¹⁾. MTA is cement composed of tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetracalcium aluminoferrite, and calcium sulfate and bismuth oxide. It is very alkaline and hydrophilic requires moisture to set making dryness not necessary, it is mixed with sterile water to make a sandy consistency⁽¹²⁾.

MTA is also used for pulp capping, pulpotomies⁽¹³⁾, apexification and sealing of perforations. It fulfills most of the requirements of an ideal filling material such as: being biocompatible with periradicular tissues, non-toxic and non-resorbable.

The aim of this study was to compare the sealing ability of MTA in three different cavity designs.

MATERIALS AND METHOD

Thirty extracted, single-rooted teeth were used in this study, the root canals of the teeth

were cleaned and shaped using step-back technique and obturated with Gutta Percha and zinc oxide eugenol as a sealer using lateral condensation technique, the coronal access cavity was filled with temporary filling, all the teeth were stored in an incubator in 37°C and 100% humidity.

The apical 3 mm. of each root was resected at a 90 degree to the long axis of the root, to ensure standardization and facilitate root-end cavity preparation, using a high speed hand piece (W&H, Austria) and a diamond fissure bur (SF-41, Mani. INC. Japan).

The teeth were randomly divided into 3 groups each consisting of 10 teeth, as follows:

- **Group 1:** in this group the root-end cavity preparation was carried out using right-angled low speed hand piece (W&H, Austria) and a carbide round bur (1/009, Busch&CO, Germany) under copious irrigation with distilled water, the depth of the cavity was 3 mm. and the buccal and lingual walls of the cavity were made parallel.
- **Group 2:** the root-end cavity was prepared using ultrasonic retrotip (7D S12 F00118) (Figure 1), mounted on a Satelec unit (France) (Figure 2) under copious irrigation with distilled water and 3 mm. depth.
- **Group 3:** the root-end cavity preparation, in this group, was done by using right-angled low speed handpiece (W&H, Austria) and an inverted cone carbide bur (2/008, Busch, Germany) under copious irrigation with distilled water, the depth of the cavity was made 3 mm. with a buccal and lingual undercuts.

All the root-end cavities were filled with MTA (Angelus, Brazil) (Figure 3) after mixing with distilled water following the manufacturer's instructions, the final setting of the filling (the setting time is 15 minutes), the roots of the teeth were coated with nail varnish and the apices of the teeth were immersed in 2% methylene blue dye (C.I. 52115, England) in an incubator for 48 hours. Then the teeth were removed and washed under running tap water.

The roots were split longitudinally buccolingually using high speed handpiece (W&H, Austria) and a diamond fissure bur (SF-41, Mani. INC. Japan) (Figure 4). The filling material and Gutta Percha were removed and the cavities were examined and the linear dye penetration was measured in tenth of millimeters using a stereomicroscopic (Hamilton by Altay) and graded scale.

The microleakage of the dye was measured from the tip of the root-end cavity preparation to the deepest point where the dye was apparent. The measurements were registered and analyzed.

RESULTS

The descriptive statistics (mean values and standard deviations with the minimum and maximum values) are presented in Table 1 and Figure 5.

Analysis of variance (ANOVA) test was performed to test the difference between the mean of dye penetration among the three experimental groups. Statistical difference was found ($P < 0.05$) among the three experimental groups (table 2). The least significant difference (LSD) test was then used for multiple comparisons between the three experimental groups. The results of comparison between each pair of groups showed significant difference ($P < 0.05$) between groups (Table 3).

DISCUSSION

Microleakage has been defined as the passage of ions, molecules, fluids or bacteria between the cavity wall and the applied restorative material. It has been reported to cause failure of endodontic treatment⁽¹⁴⁾.

The extent of microleakage depends on many factors, these can be divided into; those that are related to the restorative materials used such as expansion and contraction, and those that are related to the cavity preparation.

Endodontic surgery is indicated when the conventional endodontic treatment is impossible or has failed and when the endodontic retreatment is not possible, it usually consists of apicectomy and retrograde filling which aims to create an apical seal to prevent the passage of microorganisms and/or their products from and into periapical tissue. Apical seal is the single and most important factor in achieving success in surgical endodontics⁽¹⁵⁾.

Many materials have been used as retrograde filling materials, Amalgam is the most commonly used one, but many authors have found that MTA has better sealing abilities than other retrograde filling materials, it was also suggested that MTA induces healthy apical tissue formation and less inflammation^(15, 16, 17).

Several *in vitro* techniques for assessment of microleakage were reported using: staining, scanning electron microscope, bacterial activity, decay, air pressure, chemical agents, markers, neutron activation analysis, radioisotopes,

ionization autoradiography and reversible radioactive adsorption.⁽¹⁴⁾

Dye penetration techniques still remain one of the commonest methods to test sealing ability of restorative materials.

Methylene blue is a commonly used dye; it was found that its leakage is comparable with that of the small bacterial product of similar molecular size⁽¹⁸⁾. One molecule of methylene blue equals 1.2 nm^2 which equals 120 \AA^2 , this particle size is less than that of the bacterial one.

In this *in vitro* study the dye penetration in the group 1 (control group), prepared by a round bur and a low speed, angled handpiece, was less than that of group 2, that received ultrasonic preparation, the difference between these two groups was statistically significant ($p < 0.05$). It is suggested that this is due to the possible microfractures, cracks and surface changes of the cavity walls after ultrasonic preparation which were seen by many authors to be significantly more than those seen in cavities prepared by burs⁽¹⁹⁻²²⁾. Another study⁽³⁾ found that ultrasonic tip produced conservative preparation but it disturbs the Gutta Percha filling and that preparation using burs produced the smoothest cut surface.

Calonette et al⁽²³⁾ using in situ impression technique argued that these microfractures occur only in cavity preparation of extracted teeth due to drying and that the periodontal ligament act as shock-absorbing effect that absorbs the vibrations of the retrograde preparation and can thus prevent microfractures and cracks.

This finding is supported by the prospective study⁽²⁴⁾ that showed a very high success rate (96.8%) of retrograde fillings prepared by ultrasonic units over a period of 14 months follow up.

In group 3, the root-end cavity was prepared using inverted cone carbide bur for 3 mm depth and buccolingual undercuts, undercuts were used in root-end cavity preparation to apply additional retention if the shape of the root at the resection cross section permits this especially in cavities less than 3 mm in depth⁽²⁵⁾. It was found that the dye penetration was the least in this group which showed a better sealing ability than both groups 1 and 2, the difference was statistically significant ($p < 0.05$).

We suggest that creating undercuts in the cavity preparation increases the surface area of contact between the dentinal wall of the cavity and the MTA, as studies have shown that increasing the thickness of MTA increases its sealing ability^(26, 27).

Sarkar et al.⁽²⁸⁾ found that MTA forms an adherent interfacial layer with dentinal wall,

calcium ions released from MTA reacts with phosphates in synthetic tissue fluid yielding hydroxyapatite, the dentine-MTA interfacial layer results from a similar reaction, and they concluded that the sealing ability, biocompatibility and dentinogenic activity of MTA is attributed to these physicochemical reactions.



Figure 1: Ultrasonic retrotip.



Figure 2: Satelec ultrasonic unit.

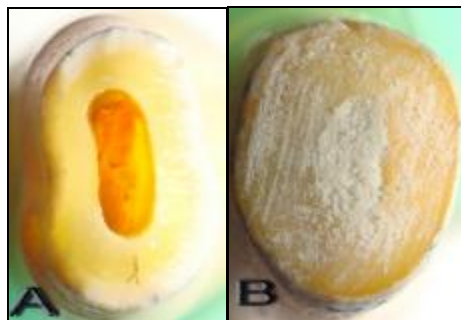


Figure 3: A; Retrograde cavity preparation. B; Filling with MTA.



Figure 4: The root split longitudinally buccolingually.

Table 1: Descriptive Statistics for the tested groups

	N	Minimum	Maximum	Mean	Std. Deviation
Conventional	10	2.50	4.50	3.9500	.59861
Ultrasound	10	4.50	6.50	5.5500	.79757
Undurcut	10	2.00	3.50	2.7500	.42492

Table 2: Analysis of variance (ANOVA) for the tested groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	39.467	2	19.733	50.383	.000
Within Groups	10.575	27	.392		
Total	50.042	29			

Table 3: Post Hoc test multiple comparison LSD test for the tested groups

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	1.6000(*)	.27988	.000	2.1743	1.0257
	3.00	1.2000(*)	.27988	.000	.6257	1.7743
2.00	1.00	1.6000(*)	.27988	.000	1.0257	2.1743
	3.00	2.8000(*)	.27988	.000	2.2257	3.3743
3.00	1.00	1.2000(*)	.27988	.000	1.7743	.6257
	2.00	2.8000(*)	.27988	.000	3.3743	2.2257

* The mean difference is significant at the P<0. 05 level.

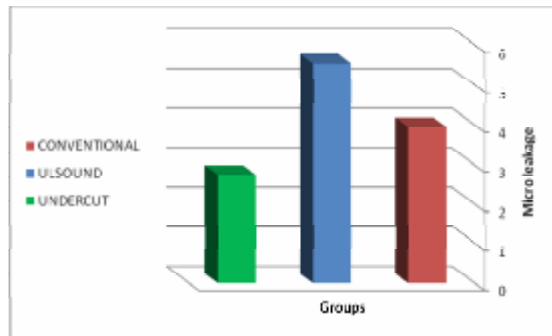


Figure 5: Bar chart for tested groups.

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