



ISSN Print: 2394-7489  
ISSN Online: 2394-7497  
IJADS 2020; 6(2): 588-592  
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[www.oraljournal.com](http://www.oraljournal.com)  
Received: 22-02-2020  
Accepted: 24-03-2020

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## ***In vitro* comparative study of the influence of post space preparation timing on apical sealing of root canal**

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### **Abstract**

**Objectives:** to compare the influence of timing of post space preparation (after 24hours, after one week) and method of post space preparation (rotary with/without solvent) on apical root canal sealing.

**Materials and Methods:** Twenty single rooted human mature were decoronated and accessed. Samples were divided into two groups depending on the time of post space preparation and method of post space preparation: (group A: warm vertical compaction/rotary preparation without solvent, group B: warm vertical compaction / rotary preparation with solvent). and divided the two groups to two halves: the first half was prepared post space after 24hours, and the other half a week later.

**Results:** There was no significant difference in penetration depth of mythelene blue dye within group A. However, significant difference in penetration depth of mythelene blue dye within group B. No significant difference was seen between post space preparation after one day and post space preparation after one week.

**Conclusion:** The different timing of post space preparation no effect on apical sealing of root canal. However, post space preparation after one week better than one day, when using rotary removal of gutta-percha with solvent.

**Keywords:** Warm vertical compaction, ADSAEL, post space preparation, solvent, apical sealing

### **1. Introduction**

Endodontic treatment is defined according to the American Association of Endodontic Therapists: (2016)

"The branch of dentistry is concerned with the study of the pulp of the tooth in terms of form, function and pathological disorders, in addition to human peripheral tissues <sup>[1]</sup>.

The goal of this treatment becomes to maintain the functional and aesthetic performance of the tooth at the expense of the pulp vitality when the severity and quality of the injury exceed the defensive lines of the pulp of the tooth, whereby the coronary core treatment based on the pulpectomy, cleaning, formation, and purification of the root canal system is indicated, and then the three-dimensional sealed filling of the prepared duct space <sup>[4]</sup>.

Securing the 3D impermeable seal of the cannula system will prevent the entry of germs and tissue fluids that will help the remaining germs within the duct system to continue their pathological efficacy <sup>[22]</sup>.

Achieving 3D canal filling is a necessary and necessary condition to achieve successful endodontic treatment in the short term, but it is not sufficient in the long run and it must be accompanied by a good final coronary restoration to maintain the quality of the canal filling and restore the permanent functional rehabilitation of the age <sup>[4]</sup>.

Several restorations have been used to achieve this, some of which relied on post and core restorations, which require several procedures, including the post space preparation, which was the focus of multiple studies in investigating its impact on the quality of the remaining footnote <sup>[4]</sup>.

In terms of post space preparation, the required post space may be prepared either immediately after the completion of the endodontic procedure using hot pluggers or alternatively at a later stage after full setting of the sealer using rotary instruments <sup>[11]</sup> Performing post space immediately after root canal obturation but before sealer cement sets may, however mean that the apical seal remains intact. Yet the common procedure is late removal of the coronal part of

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the root canal filling at a subsequent visit. If post space and post itself are prepared in the same session as the root canal fillings, these aseptic conditions may be easily followed with no additional efforts but in some cases the evaluation period is needed to analyse the restorability of the tooth with post & core. Since there are different schools of thoughts regarding the critical time to carry out this procedure, this aspect is under extensive research<sup>[11]</sup>.

Thus, the aim of this study was to compare the influence of timing of post space preparation and method of post space preparation on apical root canal sealing.

## 2. Materials and Methods

Sample size calculation was done using G\*power program v.3.1 (Heinrich-Hein- Universität Düsseldorf, Germany; <http://www.gpower.hhu.de/>), and 20 freshly extracted human mature single-rooted were determined as the total specimens. Tooth selection criteria were as follows: single canal, no external or root internal resorption, lack of tooth caries, cracks or developmental anomalies under 20X magnification, and no previously endodontically treated canals, with canal curvature of no more than 5° according to Schneider [26].

Teeth were debrided using CK6 hand instrument (Zeffiro-Lascod, Florence, Italy) to remove all tissue debris attached to the root surface after extraction. Then, teeth were stored in a plastic container with 0.5% chloramine T for 1 week to sterilize the specimens, before they were moved to another plastic container with 0.9% saline and kept in a refrigerator at 4 °C until used.

### 2.1. Sample preparation

The crown of teeth were shortened using a diamond disk (Edenta, Switzerland) to standardize the length at 16 mm using a digital caliper.

Conventional access cavity was done using a 2mm round bur, and the roof of the pulp chamber was removed with Endo-Z bur (Dentsply, Switzerland). The pulp of each tooth was extirpated with barbed broaches (VDW, Germany). The working length was measured after locating the apex with a 15# K-file until the tip of the file was observed from the apical foramen, then subtracting 1mm from the canal length.

### 2.2. Root canal preparation

Canals were prepared with Mtwo system (VDW; Germany) following the basic instrument sequence until #35 along the entire working length using a gentle in and out motions. Preparation was done according to manufacturer's instruction regarding the speed and torque. 2 ml of 5.25% NaOCl was irrigated after each instrument.

After completion of the preparation, the washing was performed with sodium hypochloride 3 (ml) for each channel, then using EDTA for a minute to remove the smear layer, final wash with physiological serum, and dry with paper cones.

The prepared canals were obturated using warm vertical obturation technique and the resin sealer ADSEAL of groups 1 and 2 where:

- The temperature of the device was set to (200) degrees Celsius.
- The main cone was selected according to the phenomenon of tug back, to be 1-2 mm less than the working length. After that, the vertical plugger was tried in the prepared canal to cut and condense the cone, as it should move away from the apical 4-7 mm.
- A cement-coated cone was inserted into the apical one-

third of the canal and cut at the orifice of the canal with a heated plugger.

- We then inserted the 200 °C heated plugger into the gutta-percha and stopped when the rubber marker reached the grinding surface.
- We applied a constant pressure for 8-10 seconds to reduce the sclerosis shrinkage of gutta-percha.
- We heated the plugger again for a second and then removed the coronal and intermediate gutta-percha, thereby filling the apical third.
- After that the apical area was condensed with the tip of the plugger, The filling of the canal has been followed up by injecting the gutta-percha into the canal.
- To ensure good condensation of the gutta-percha and perfect application with the walls of the canal, the injection was carried out slowly so that the injection layer thickness did
- Not exceed 5 mm, and to get rid of the shrinkage hardening of the gutta-percha material was condensed with a stainless steel condenser for each injected layer so that we keep pressing for 5 seconds.

### 2.3. Post space preparation

The two groups was divided into two halves: the first half the root post space was prepared 24 h after the root canal filling, and the other half a week later. The root post space was prepared using a low-speed grip and Gates Glidden burs for group 1. Gates Glidden burs and the chemical solvent (Xylol) were also used to prepare the post space for groups 2. So that the remaining 5 mm of the retaining material was preserved in all teeth of the study sample.

The external root surface was painted with two layers of nail polish except the most apical 2mm. A preliminary study was conducted in order to determine the most appropriate period for the type of sectioning (cross sectional vs. longitudinal), and the pigmentation process in which teeth were submerged in the methylene blue dye for 12 or 24 or 48 hours, and the final period was found to be the appropriate one to stain the hole root canal.

Specimens were submerged in a plastic container with methylene blue dye for 24 hours in 37°C temperature. Teeth were then washed with running water to flush away the dye.

### 2.4. Study groups

Specimens were randomly distributed into two groups based on the timing of post space preparation and method of post space preparation as follows:

Group A (n=10): warm vertical compaction/rotary post space preparation without solvent.

Group B (n=10): warm vertical compaction/rotary post space preparation with solvent. and divided the two groups to two halves: the first half was prepared post space after 24hours, and the other half a week later.

### 2.5. Apical dye leakage

The amount of apical leakage was measured from the cement dentinal junction to the furthest point of coronal reached by the methylene blue pigment according to the following criterion:

1. Not found any penetration of the pigment.
2. The presence of an apical leakage of the pigment in the coronal direction up to 0.5 mm.
3. The presence of an apical pigment leakage in the coronal direction from 0.5 mm to 1 mm.

4. The presence of a peak pigment leakage in the coronary direction from 1 mm to 2 mm.
5. The presence of an apical pigment leakage in the coronal direction more than 2 mm.

**2.6. Teeth sectioning and measuring the depth of methylene blue penetration**

Teeth were sectioned longitudinally after creating a groove of 1 mm depth on the mesial and distal surface of the root under an endodontic microscope. Then, each tooth was put on a polyvinyl siloxane model in order to separate the two sections with a chisel and a mallet [23].

Two parallel lines, 3 mm apart, were drawn on the surface of each section to calibrate the image. Each section was captured with a digital camera (Samsung NX500, Samsung; USA) under an endodontic microscope (Meiji; Japan).



**Fig 1:** A longitudinal section showing the penetration of the pigment within group A.



**Fig 2:** A longitudinal section showing the penetration of the pigment within group B.

**3. Statistical Analysis**

Normality of distribution was checked with Kolmogorov-Smirnov test. Data showed normal distribution. Thus, Mann-Whitney U test was used to determine if there was a statistically significant difference in methylene blue dye penetration depth between group A and group B in apical third according to post space preparation method, and Kruskal-Wallis test to determine if there was a statistically significant difference in the depth of dye penetration in apical third regarding timing of post space preparation.

Data were analyzed using SPSS V. [23] (IBM; CORP., ARMONK, USA). The level of the P value was set 5%, and the level of confidence was set at 95%.

**4. Results**

Descriptive results including deviation of methylene blue dye penetration depth in apical third of the root canal (Table 1).

**Table 1:** Shows descriptive results including standard deviation of methylene blue dye penetration depth in apical third of the root canal.

Apical dye leakage						Timing of post space preparation	
Total	Measurement (4)	Measurement (3)	Measurement (2)	Measurement (1)	Measurement (0)		
5	2	2	0	1	0	After one day	Group A
5	1	2	2	0	0	After one week	
5	4	1	0	0	0	After one day	Group B
5	0	1	2	1	1	After one week	

**Table 2:** Shows descriptive results of Mann-Whitney U test to study significant differences of the penetration depth of methylene blue dye in apical third regarding post space preparation method.

Post space preparation method	U value	P value	significant differences
Warm obturation/rotary removal without solvent	10.0	0.584	No significant difference
Warm obturation/rotary removal with solvent	0.5	0.009	significant difference

Mann-Whitney test showed no significant difference in penetration depth of methylene blue dye in apical third of the root canal within group A (Warm obturation/rotary removal without solvent) (P=0.584). However, significant difference in penetration depth of methylene blue dye in apical third of the root canal within group B (Warm obturation/rotary removal with solvent) (P=0.009) (Table 2).

Kruskal-Wallis test for to study significant differences of the penetration depth of methylene blue dye in apical third regarding timing of post space preparation showed no significant difference was observed between timing of post space preparation after one day and timing of post space preparation after one week.(P=0.311, 0.333 respectively) (Table 3)

**Table 3:** Shows descriptive results of Kruskal- Wallis test to study significant differences of the penetration depth of methylene blue dye in apical third regarding timing of post space preparation.

Timing of post space preparation	Kai square value	Degrees of freedom	P value	significant differences
After one day	5.949	5	0.311	No significant difference
After one week	5.736	5	0.333	No significant difference

## 5. Discussion

Endodontically treated teeth with insufficient coronal tooth structure generally require radicular posts to assist in restoring the tooth to function. The required post space might be prepared immediately after completion of the endodontic treatment or at a later stage after full setting of the sealer. But during the preparation of the post space, it is important not to disrupt the integrity of the apical seal [31].

In accordance with this purpose, while the post space was being prepared, the effects of root canal filling materials, root canal filling removal techniques, removal times, and the level of the remaining gutta-percha on micro leakage were investigated in several studies [3, 6, 19, 29]. Unfortunately, there is no definite consensus on the research. Whereas some studies [18, 29] indicate that the removal of gutta-percha immediately after root canal filling results in less micro leakage, others [3, 12, 20] indicated no difference. When the removal techniques of gutta-percha and sealer were compared, Mattison *et al.* [20] indicated that chemical removal results in more micro leakage in comparison with mechanical and thermal techniques. However, Madison *et al.* [19] stated there was no difference among the 3 gutta-percha removal techniques (chloroform and files, heated instrument, mechanical techniques). Also, Camp and Todd [7] stated that there is no difference between the mechanical and thermal techniques.

In the light of these studies, we aimed to compare the influence of timing of post space preparation (after 24hours, after one week) and method of post space preparation (rotary with/without solvents) on apical root canal sealing.

For restorative procedures of endodontically treated teeth, post spaces are usually prepared with rotary instruments at a subsequent visit after the complete curing of the sealer [14]. These protocols may compromise the apical seal, producing bacterial leakage and failure of the restoration [19]. In the clinical setting, it is frequently necessary to leave a minimal remnant of gutta-percha to increase post retention. In this study, 5 mm of gutta-percha was left in the apical parts of the root canals as Abramovitz *et al.* [16] reported leaving 3 to 6 mm of gutta-percha was sufficient to maintain an apical seal. However, in a study by Metzger *et al.* [2], leaving less than 7 mm of gutta-percha apically was demonstrated to diminish the quality of the apical seal and it was concluded that the sealing was proportional to the length of the remaining filling.

Methylene blue dye was chosen in this study Due to the ease of handling it, its good ability to color, its cheapness, and its leakage in a way that simulates the toxins of most germs [10].

This study assessed the penetration depth after sectioning teeth longitudinally with a chisel and a mallet, in order to maintain the inside portion of the root canal intact and preserve it from damage that could be attributed due to diamond disc sectioning.

With regards to timing of post space preparation, The present findings showed that no significant difference exists between removal of gutta-percha after one day and removal of gutta-percha after one week.

This was consistent with Gungor *et al.* [14], Aydemir *et al.* [5], Grecca *et al.* [15] and Yildirim *et al.* [28], Chen *et al.* [8] study

that showed no significant difference in timing of post space preparation.

While according to method of post space preparation, this study showed rotary removal of gutta-percha with solvent after one week showed statistically less leakage values than rotary removal of gutta-percha without solvent after one day. This means that rotary removal of gutta-percha without solvent can be better than rotary removal of gutta-percha with solvent. This was consistent with Mattison *et al.* [20], that showed the chemical removal of gutta-percha consistently showed significantly more leakage than either the mechanical or the thermal method. The increased leakage in teeth prepared by the chemical method was probably due to a dimensional change of the gutta-percha that occurs after the evaporation of the solvent. There is a reported 7.5% loss in mass caused by shrinkage when chloroform is used with gutta-percha [27]. Decreased leakage with Gates-Glidden drills might be explained by the frictional heat created by the rotary action. Gutta-percha has the property of expansion when heated, which decreases the space in the gutta-percha dentinal wall interface. Decreased leakage with Gates-Glidden drills for post space preparation has been reported in a previous study [18].

This study was not consistent with Dhaded *et al.* [11] study which revealed that the Immediate removal of gutta-percha showed less gaps than delayed preparation. However, this could be attributed to the different type of sealer, root canal obturation technique and method of post space preparation used in their studies. Bodrumlu *et al.* [6], Sadeghi *et al.* [24] and Solano *et al.* [29] showed increased leakage with delayed post space preparation, but this difference could be related to the different ways used in their study compared with this study.

## 6. Conclusions

The different timing of post space preparation no effect on apical sealing of root canal. However, post space preparation after one week better than one day, when using rotary removal of gutta-percha with solvent.

## 7. Acknowledgment

This study has been carried out at the department of Operative Dentistry, Faculty of Dentistry, Hama University, Syria, which deserves a great appreciation for all academic and financial support.

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