



Evaluation of Sealing Ability of Totalfill® versus ProRoot MTA in Furcal Perforations in Permanent Molars Using Scanning Electron Microscopy (SEM)

Noha M. El Najdi^{1*}, Mohamed H. Mostafa², Eman AR. Mohamed³

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azhardentj@azhar.edu.eg

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ABSTRACT

Purpose: to evaluate the sealing ability of Totalfill® versus ProRoot MTA in furcal perforations in permanent molars using Scanning Electron Microscopy (SEM). **Materials and Methods:** Thirty permanent molars were placed in 5% sodium hypochlorite solution and washed with tap water. Access cavities were made using round bur in high-speed handpiece. Perforations were made in the middle of the pulpal floor using size 4 round bur. The teeth were divided into two groups according to the material used to seal the perforation; Group I: ProRoot MTA and Group II: Totalfill®. The materials were left to set then the samples were sectioned longitudinally and the gap between the material and dentin was measured by SEM. **Results:** The results of this study showed that Group I (ProRoot MTA) showed more microleakage ($17.47 \pm 5.58 \mu\text{m}$) compared to Group II (Totalfill®) that showed significantly less leakage ($5.28 \pm 2.18 \mu\text{m}$). **Conclusion:** Based on the results of this study, it was concluded that Totalfill® showed better sealing ability and lesser microleakage than that of ProRoot MTA and therefore it can be a good alternative to MTA.

INTRODUCTION

Incidental or accidental perforations of the floor of the pulp threaten the prognosis of the treatment of the tooth. Accidents like sudden movement of the child during the procedure or because of extensive caries or lastly iatrogenic perforations during attempts to locate the canal orifices are sometimes inevitable and causes perforations most commonly

KEYWORDS

Totalfill®, Furcal perforation,
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- 1. Dentist at Demerdash Hospital.
- 2. Assistant Professor, Head of Pedodontics and oral Health Department, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt
- 3. Lecturer of Pedodontics and Oral Health Faculty of Dental Medicine for girls Al-Azhar University, Cairo, Egypt.

* Corresponding author email: noooohanany@hotmail.com

at the floor of the pulp chamber or so-called furcal perforations⁽¹⁾. A wide selection of materials has been used like zinc oxide eugenol cements, calcium hydroxide, amalgam, gutta-percha, composite resin and glass ionomer to seal the perforation which subsequently will block the passage for the bacteria to enter and cause inflammatory response and lead to loss of the tooth⁽²⁾.

Nowadays bioceramic materials' introduction has made a leap in dentistry as they act as bioactive materials. MTA is the first bioceramic material discovered by Dr. Torabinejad in 1993 and composed of tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide and bismuth oxide⁽³⁾. There are two forms of MTA; ProRoot MTA and MTA Angelus. Although MTA is close to the ideal requirements and is the gold standard to the root repair materials, it made us face several drawbacks as difficult handling and long setting time⁽⁴⁾.

Totalfill® a relatively new bioceramic root repair material developed as ready to use, premixed material. Totalfill® is a mixture of calcium silicate and calcium phosphate which is highly resistant to washout and ideal for all types of root repair besides having better handling than MTA and is applied directly to perforation area using disposable tips. It has been claimed that this material can be used for perforation repair, apical surgery, apical plug, and pulp capping⁽⁵⁾.

Therefore, the present study was planned to evaluate the sealing ability of ProRoot MTA and Totalfill® in furcal perforations in permanent molars using Scanning Electron Microscope.

MATERIALS AND METHODS

This study has been approved by the Ethical Committee, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt. Ethical concerns related to some of the extracted molars may not be known as already extracted teeth was collected from different dental institutes and private clinics, but it is assumed that they are extracted because of caries, periodontal problems, or preventive orthodontic treatments.

Case selection:

A total number of thirty human permanent molars was included in this study from different dental institutes and private clinics. The selected teeth should have non-fused well-developed roots, intact pulpal floor with no cracks or extensive decay⁽⁶⁾.

Preparation of the samples:

After extraction, teeth were placed in 5% sodium hypochlorite for 30 minutes for disinfection and removal of tissue remnants, the teeth were washed with tap water and kept in normal saline until they were used for the study.

Teeth were removed from the saline and dried with air. The molars were decoronated 3mm above cemento-enamel junction and the roots were amputated 3mm below the furcation area using tapered diamond stone mounted on a handpiece (Sirona, USA) for easier handling. A standardized endodontic access opening was made in each tooth using number #4 round bur in a high-speed hand piece with air water coolant, and the orifices were detected.

To guarantee each perforation is centred between the roots, a black marker pen was used to mark the location of the defect. False perforation was made from the outside surface. Teeth were dried, sticky wax was placed over the orifice of each canal to avoid the materials from going into the orifices when placing them into the perforation site and two successive layers of nail polish were used to coat the teeth to increase marginal seal except for 1-2 mm around perforation⁽⁶⁾.

Grouping of teeth:

The samples were divided into two groups:

Group I: 15 molars in which perforations were repaired with ProRoot Mineral Trioxide Aggregate (MTA)

Group II: 15 molars in which perforations were repaired with Totalfill® (premixed Bioceramic Root Repair Material paste).

In Group I, the perforation site was repaired with

ProRoot MTA, the powder was mixed with supplied sterile water using stainless steel spatula and over a clean, dry glass slab in a ratio 3:1 powder to liquid ratio (thick creamy consistency). Then the material was placed with MTA carrier and compacted with a hand plugger. A moistened cotton pellet was placed in the chamber for 24 hours to ensure complete setting of materials and simulate wet clinical field.

In Group II, the perforation site was repaired with Totalfill®. The Totalfill® is a premixed paste presented in a syringe. It is placed by the supplied applicator disposable tips directly into perforation sites⁽⁷⁾. All teeth were placed in a silicon impression material until set to simulate socket⁽⁸⁾.

Sealing Ability Test

After 24 hours, the samples were sectioned using a hard tissue microtome. The teeth were removed from the set silicon impression material and placed

from the crown part and glued on a wax block by flowable composite for fixing the teeth before placing it in the microtome chamber and adjusted so the disc from the other side cut between the roots right in the middle of the furcation. Thus creating a longitudinal section.

The samples were viewed under SEM after gold sputtering in two different magnifications (130x and 500x) for evaluating the sealing ability and the intramolecular space between the materials. The microleakage was evaluated by measuring the gap (in μm) between the pulpal floor and the material used for the furcal repair⁽⁹⁾.

RESULTS

Under the SEM the gap between the material and the dentin was measured. A magnification of 130x was taken to show the overview and 500x for the measurements to be taken (Fig.1).

SEM:

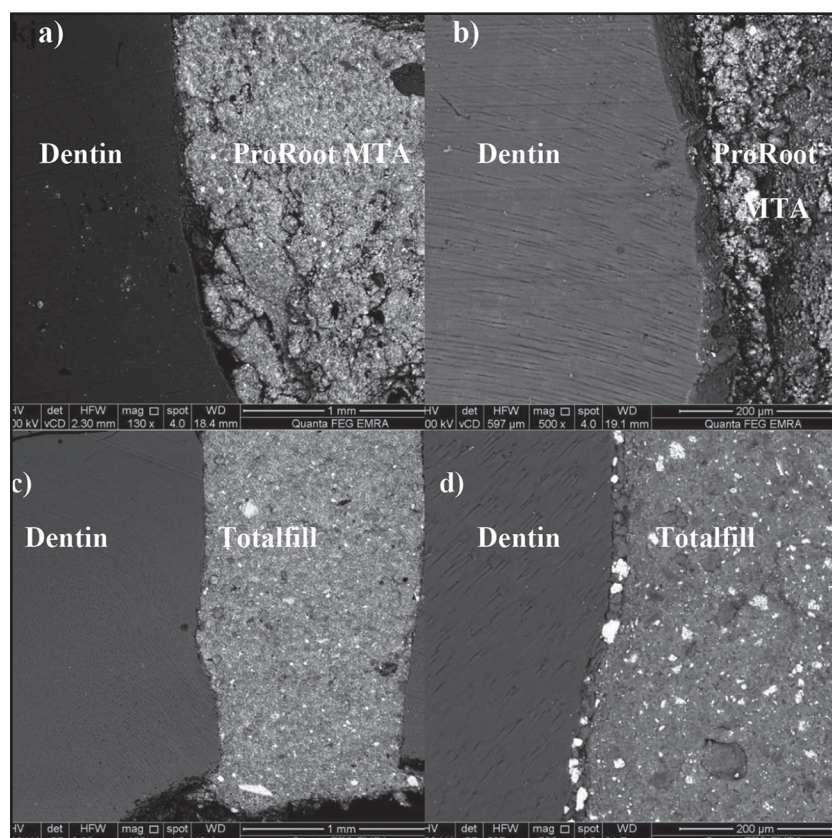


Figure 1: a) SEM of a tooth repaired by ProRoot MTA in its furcal perforation at magnification 130x. b) SEM of a tooth repaired by ProRoot MTA in its furcal perforation at magnification 500x. c) SEM of a tooth repaired by Totalfill® in its furcal perforation at magnification of 130x. d) SEM of a tooth repaired by Totalfill® in its furcal perforation at magnification of 500x.

To determine the effectiveness of each of the two sealing materials, results were analyzed by comparing the marginal gaps in the two groups using the descriptive and Wilcoxon signed-rank test.

According to the general descriptive statistics of marginal gaps for two groups (table 1), the SEM examination showing that the marginal gap was lesser in Total Fill ($5.28 \pm 2.18 \mu\text{m}$) when compared to that of MTA ($17.47 \pm 5.58 \mu\text{m}$). Which indicated that Totalfill® is better in sealing ability as the gaps were lesser than in those treated with MTA (Table 1).

Table (1) General descriptive statistics summary (total number of samples (N), mean, standard deviation, minimum, and maximum) of groups Totalfill® and MTA.

	N	Mean	Std. Deviation	Minimum	Maximum
TotalFill®	15	5.53	2.18	3.11	8.99
MTA	15	17.47	5.58	11.49	31.92

According to Wilcoxon Signed Ranks Test (table 2), the number of Negative Ranks is zero, while the positive Ranks number is 15, this means that all marginal gap values of the MTA group are higher than that of TotalFill® group values. Additionally, the value of Ties is zero, meaning there are no equal values between the two groups.

Moreover, the result of the p-value was 0.001 ($P < 0.05$) which indicates that there are statistically significant differences between the two groups in favor of MTA which have a higher mean (MTA mean $>$ TotalFill® mean). That confirmed the efficiency of Totalfill® as a sealing material (Table 2).

Table (2) Wilcoxon Signed Ranks Test for the marginal gaps of the two groups:

	N	Mean Rank	P-Value*
MTA - Total Fill®	Negative Ranks	0 ^a	0.001
	Positive Ranks	15 ^b	
	Ties	0 ^c	
	Total	15	

a. $MTA < TotalFill®$

b. $MTA > TotalFill®$

c. $MTA = TotalFill®$

* Wilcoxon Signed Ranks Test

DISCUSSION

Despite prognosis of teeth with furcal perforations depend on multiple factors, yet it is of great importance to choose a material with good sealing ability to ensure complete closure of the passage between the root system and the periodontium ⁽¹⁰⁾. This study evaluated the sealing ability of two bio-ceramic materials in furcal perforations in permanent molars. The clinical uses of bioceramics have increased exponentially over the years because of their wide range of applicability in restorative dentistry, endodontics and pedodontics.

MTA has properties closest to the ideal requirements. However, some limitations made researchers look for alternatives ⁽¹¹⁾. An alternative material to MTA with improved handling properties has been manufactured, which is ready made syringe TotalFill®.

Permanent molars were used in this study as perforations might occur during endodontic treatment in young patients due to sudden movement or iatrogenic and its mandatory to do our best to save the tooth especially that the first molars are occlusal guidance and are important in chewing and mastication. The extracted teeth were kept in 5% sodium hypochlorite for 30minutes to clean and eliminate tissue remnants. Each tooth was decoronated 3 mm

above the cemento-enamel junction and the roots were amputated 3 mm below the cemento-enamel junction for easy handling⁽⁹⁾. After the perforation was made and grouped and treated with the materials, the teeth were placed into silicone impression material to simulate the bony socket⁽⁸⁾.

For more accurate longitudinal cutting of the samples, a hard tissue microtome was used to cut exactly in the middle of the perforation. The samples were viewed under SEM as this method does not require creation of resin replicas which does not result in artificial gap. SEM has high magnification and good resolution and gives the opportunity to view images in three-dimensions⁽¹²⁾.

The results of the present study showed that there was a statistically significant difference (p -value=0.001) between the MTA and Totalfill® in the sealing ability in favor of Totalfill® as the gap measured between the MTA and dentine was more than the gap measured between Totalfill® and dentine.

The results of this study came in agreement with a previous study that evaluated the sealing ability of MICRO-MEGA Mineral Trioxide Aggregate, Endosequence (recently Totalfill®), Biodentine as furcation repair materials using a dye extraction leakage method. It concluded that Biodentine showed highest dye absorbance, whereas Endosequence showed lowest dye absorbance when compared with other repair materials and therefore better sealing ability⁽¹³⁾. The results are in agreement despite using dye extraction method with its limitations as an assessment method. Also, Endosequence (now Totalfill®) showed better results even when compared with MICRO-MEGA (MM) MTA which is modified MTA and delivered in caps overcoming the drawbacks of MTA. This is maybe related to the material's particle size as premixed materials allows them to infiltrate into the dentinal tubules and gets glued to the adjacent dentin.

However, the results of this study came in disagreement with a previous study where Totalfill® showed better furcation sealing ability as compared

to Biodentine and MTA Plus materials but with no significant differences⁽⁵⁾. This may be due to using dye extraction method where the teeth were stored in 5ml of nitric acid for 3 days after materials were placed and this was done to be centrifuged to be viewed and analyzed in UV Spectrophotometer. The acid used may react with the materials affecting the results. Moreover, methods using dyes are not reliable as they are highly depending on their molecular weight and size which may either exaggerate or give underestimation to the amount of dye passed.

CONCLUSION

From the present study, Totalfill® proved to be more effective than ProRoot MTA in sealing the furcal perforations.

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