



COMPARATIVE EVALUATION OF RADIOGRAPHIC ASSESSMENT AND MICROLEAKAGE BETWEEN CONVENTIONAL AND A NOVEL METHOD OF ORTHOGRADE PLACEMENT OF MTA AT THE ROOT APEX- AN INVITRO STUDY.

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Abstract:

Context: New method of orthograde placement of mineral trioxide aggregate at the root apex to overcome the existing difficult placement.

Aim: To introduce a novel method of creation of a dense MTA plug at the root apex in open apical foramen cases.

To evaluate the radiographic assessment of apical plug and microleakage between conventional and a novel method of orthograde placement of MTA at root apex.

Settings and Design: In-vitro study with custom made alveolus replica.

Methods and Materials: 30 decoronated human maxillary central incisors were selected and open apex was created using peeso reamer of size 1- 6. They were then placed in custom made alveolus replica and divided into 2 groups.

Group 1: MTA placed using conventional messing gun method.

Group 2: MTA placed using novel method. This method comprised of making an impression of the apical third with gutta-percha stick, fabrication of solid MTA extra-orally and its placement in the root apex.

Then, radiographic assessment by clinicians and microleakage study using 2% methylene blue solution were performed.

Statistical analysis used: The data was analysed by Mann-Whitney U test.

Results: Clinicians reported superiorly condensed apical plugs when novel method was used. The novel method also revealed less microleakage compared to conventional method with statistically significant difference ($p < 0.001$).

Conclusion: Novel method was easy for orthograde placement of MTA at the apex and showed excellent compaction and had the least microleakage than conventional method.

Key Messages: Novel method will resolve the problems faced by conventional method and produce better apical seal.

Key words: Mineral Trioxide Aggregate (MTA), Apical Plug, Microleakage.

Introduction

Management of teeth with necrotic pulp and incompletely formed root apex is a challenging task because of lack of apical barrier.^[1] Calcium hydroxide has been widely used but requires variable period from 5–20 months to form the hard tissue barrier.^[2] Newer materials such as MTA and Bioceramics are replacing the use of Calcium hydroxide for the same.^[3] MTA has proven benefits over calcium hydroxide except for the disadvantage of difficult manipulation and placement during clinical procedure.^[4]

The aim of this study is to evaluate

1. The radiographic assessment and
2. The microleakage

between conventional and a novel method of orthograde placement of MTA at the root apex.

Subjects and Methods:

Materials Used:

1. Peeso Reamer- numbers 1, 2, 3, 4, 5, and 6 (LOT P15E058500) [Mani, India]
2. Gutta-Percha Sticks [Neelkanth, Jodhpur, India]
3. Addition Silicone (LOT-287569) [Zhermack Elite HD+, Italy]
4. Mineral Trioxide Aggregate (LOT-101305) [MTA ANGELUS, Brazil]
5. Messing Gun [GDC, India]
6. Root Canal Pluggers [GDC, India]
7. Coaxial Wire [GDC, India]

8. RVG [Vatech EZ sensor, India]
9. 2% Methylene blue [Chenchems, India]
10. Stereomicroscope [Micron OPTIK, PRIME, India].

Methodology:

30 human maxillary central incisors extracted for periodontal reasons were included in this study. Teeth with root caries, root fracture and developmental anomalies were excluded. All the samples were decoronated using diamond disc with water coolant such that the root length was standardized to 15mm. The samples were randomly numbered from 1 to 30 with permanent marker. Open apex was created with peeso reamer of size 1-6 as done in previous invitro study simulating open apex teeth.^[5] The samples were then placed in custom made alveolus replica (figure 1) to mimic the clinical situation. Here an indigenously custom fabricated acrylic jig was made to hold the tooth with the floral foam at the apex to simulate the periapical tissue. Polyvinyl siloxane impression material was used around the root surface to simulate the periodontal membrane identical to previously done studies.^[6, 7] The standardized samples were randomly divided into two groups containing 15 samples each.

Group 1 – teeth were placed in custom made alveolus replica (figure 2&3). MTA was mixed according to manufacturer's instruction to a wet sandy stage and was placed into the root canal using messing gun and gently condensed with root canal plugger of different sizes until 3mm – 4mm of MTA is built-up at the apex as suggested by Rebecca et al (2007).^[8]

Group 2- root canal impression was taken with warm gutta-percha sticks akin to rolled cone technique. The apical 3mm – 4mm impression was transferred to addition silicone to serve as a mould. MTA was then condensed into the mould layered with Teflon tape to get an MTA plug. During setting 1mm diameter coaxial wire of length 25mm was inserted into MTA to a depth of about 1 mm. The MTA with the coaxial wire was allowed to set hard for over 6 hours. After setting, the MTA plug was transferred into the root canal with a coating of freshly mixed MTA. After placement to measured length the coaxial wire was removed from the root canal with a twist.

The groups were then subjected to radiographic assessments by five endodontists who were blinded regarding the groups (Figure 4&5). They were asked to give a scoring of 0-4 as per the criteria given below.

- 0- Poor (Visible voids and poor lateral seal which may be considered clinically unsatisfactory)
- 1- Fair (Spongy plug with acceptable lateral seal and no distinct voids which may be considered clinically satisfactory)

2- Good (Well packed plug with acceptable lateral seal but with errors in length such as periapical spillage equivalent to about 1 mm protrusion of MTA beyond the apex; shorter than 3mm of plug length; apical plug length is over 4mm.)

3- Very good (Well packed plug with good lateral seal but with errors in length such as periapical spillage equivalent to about 1 mm protrusion of MTA beyond the apex; shorter than 3mm of plug length; apical plug length is over 4mm.)

4- Excellent (Well condensed plug with good lateral seal and 3mm - 4mm length of plug with no errors in length)

After radiographic evaluation the samples were subjected to microleakage test. The teeth surfaces were coated with two layers of nail varnish leaving the apical foramen and 1 mm around it exposed. All teeth were placed in petri dish containing 2% methylene blue for 48 hrs as previously performed by Sakshi Malhotra et al (2015).^[9]

Subsequently, the teeth were rinsed under running water for 2 minutes and then allowed to dry for 15 minutes. The teeth were then embedded in orthodontic resin and sectioned longitudinally in a buccolingual direction with a diamond disk using a low-speed handpiece with water coolant. The sections were examined under a stereomicroscope with (x20) magnification for evaluation of linear dye penetration (figure 6&7) as performed in previous dye leakage studies.^[9, 10]

Evaluation of Apical Leakage

Escobar et al criteria^[11] were used to evaluate the infiltration proportions:

- 0: Infiltration loss (dye penetration $0 \leq 1.5$ mm).
- 1: Simple infiltration (dye penetration 1.5–3 mm).
- 2: Medium infiltration (dye penetration > 3 mm).

Statistical analysis:

The values were entered into an Excel sheet (Microsoft) for calculation. Radiographic assessment and the apical microleakage of both the groups were analysed using Mann-Whitney U test.

Results:

Radiographic assessment showed that novel method of manipulation and placement of MTA was significantly better ($p < 0.05$) than conventional method. The mean scores of radiographic assessments showed novel method has highest number of good score compared to conventional method. [Table 1]

Both groups demonstrated dye leakage. The apical dye penetration scores by Escobar et al. criteria showed that group 1 (conventional method) had a higher frequency of medium infiltration and lower frequency of infiltration loss and group 2 (Novel method) has higher frequency of

infiltration loss with statistical significance ($p < 0.001$). [Table 2]

Discussion:

MTA is used as root-end filling material as it seals the pathways of communication between root canal system and surrounding tissues. It is nontoxic, biocompatible, insoluble in tissue fluids and dimensionally stable. It has been in use for pulp capping, pulpotomy, apical barrier formation in teeth with open apex, repair of root perforations and root canal filling.^[12] One significant demerit of the material is its difficulty in manipulation. This study introduces a new method of placement of MTA at the immature root apex. This method helps in gaining a densely packed MTA plug at the apex without gross extrusion of MTA to the periapex. The disadvantages of conventional method is the difficulty in the placement of a MTA plug at the apex of an immature tooth.^[13] According to Nosrat et al, MTA should be confined to the root canal and if extruded will cause periapical irritation and should be followed up.^[14] Conventional method of placement has increased chance of MTA extrusion. This has led to the concept and development of this novel method.

Maxillary anterior teeth were selected in the present study as they are more susceptible to trauma before root completion because of their location. To ensure standardization, teeth with similar dimensions at the CEJ were included. In this study, the canals were instrumented with Peeso reamers (1–6) until a size 6 Peeso can be passed 1 mm beyond the apex to simulate open apex. Cvek's stage 3 root development was selected because at this stage, the mesiodistal dimension of root-to-canal ratio at CEJ is nearly 1:1.^[15] In this study, we have used a custom-made alveolus replica to mimic the periapical area in open apex cases.

In the novel method, root canal impression is taken with gutta-percha sticks, because it can be moulded to the shape of the canal. Guttapercha was warmed, rolled and placed with gentle pressure to get the impression of the apical third of the canal. The perfect seal that may not be achieved with the fabrication of MTA plug made from the impression will be taken care of by the freshly mixed MTA that will be coated over the plug. Elastomeric impression was not utilised because in clinical situation it can go beyond the apex and get separated and lodged at the periapex with undesirable consequences. During condensation of MTA in the Elastomeric impression mould of the apical third, Teflon tape was used to prevent any reaction of MTA with the addition silicone. A coaxial wire was used to serve as a carrier to transfer the MTA plug into the root canal so that its capillary space and flexibility will help in its attachment to the MTA plug, the precise placement of the plug at the apex as well as its easy removal after transferring the plug in place.

The prefabricated plug is coated with freshly mixed MTA to prevent porosities and for the close adaptation to the walls of the root canal. Radiographic assessment of plug was done by five different endodontists who were blinded to minimize bias in their reporting the clinical assessment. The preliminary evaluation of the procedure when clinically preformed is usually with an intra oral periapical (IOPA) view radiograph. Hence in this study, a clinical evaluation was also included with an IOPA view radiograph.

Care was taken to see that the MTA plug prepared is not contaminated with any impurities. The use of set MTA does not significantly alter the sealing ability and the biocompatibility of MTA. It showed that no difference exists in the zone of lysis between set and freshly mixed material. There is no significant difference in the quantity of cementum or osseous healing associated with freshly placed or set MTA when used as root-end-filling material.^[16,17] Hence, it is expected that the externally set MTA plug luted with the freshly mixed MTA will be akin to the MTA directly placed through orthograde and allowed to set in the tooth.

A study by Tânia Afonso found a lower microleakage in MTA apical plug in the specimens pre-treated with calcium hydroxide as intracanal medicament.^[18] Also, calcium hydroxide increases sealing ability by producing a residual expansion of filling materials.^[19] Residual Ca(OH)_2 is also believed to promote an initial chemical and mechanical bond between dentin and MTA.^[20] This valuable Ca(OH)_2 intracanal medicament interval can be effectively used for the preparation of the MTA apical plug for the novel indirect procedure suggested from this study.

In this study, we evaluated the apical sealability of MTA as the aim of the endodontic treatment is to have fluid tight seal to prevent leakage into the root canal system.^[21] Dye penetration studies are commonly used as they do not require complicated steps and sophisticated materials.^[22] Methylene blue was used for measurement of dye penetration as it is easy to use and has similar molecular size to bacterial by-product, butyric acid which leak in infected root canals.^[23]

Though there are a number of other methods to evaluate the sealing ability of a material to dentin tissue, dye leakage studies are still being utilised by many authors.^[24,25] As dye leakage methodology is simple to use and fast, it was adopted in this study.

In vitro dye leakage studies are frequently used in endodontic research even in present days^[26,27]. Still definite extrapolation cannot be done from invitro dye leakage studies to clinical situation because of inconsistencies seen due to varying causes. They can yet be taken as fair indicator for the sealing ability of a dental

material to the dentin surface. This well sealed apical canal with MTA may result in improved clinical outcome.

Conclusion:

Within the limitations of this study it was observed that

1. The radiographic assessment of MTA placed using the novel technique showed superiorly condensed dense pack of MTA and the microleakage was also lower than the conventional method.
2. The novel method of MTA compaction will serve as an easier technique for the operator to create a superior apical seal without the fear of apical extrusion or spillage of the material.

Long-term clinical trials and investigations are further required to support this apparently improved and useful technique.

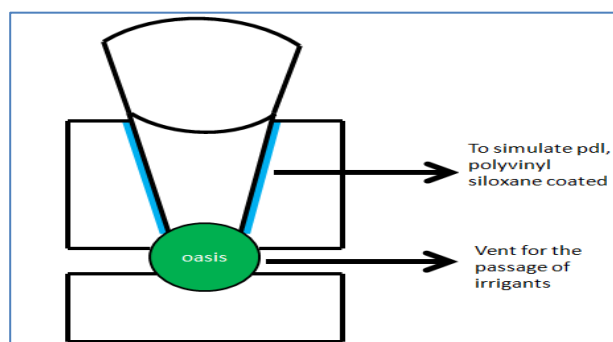


Figure 1: Schematic illustration of custom made alveolus replica

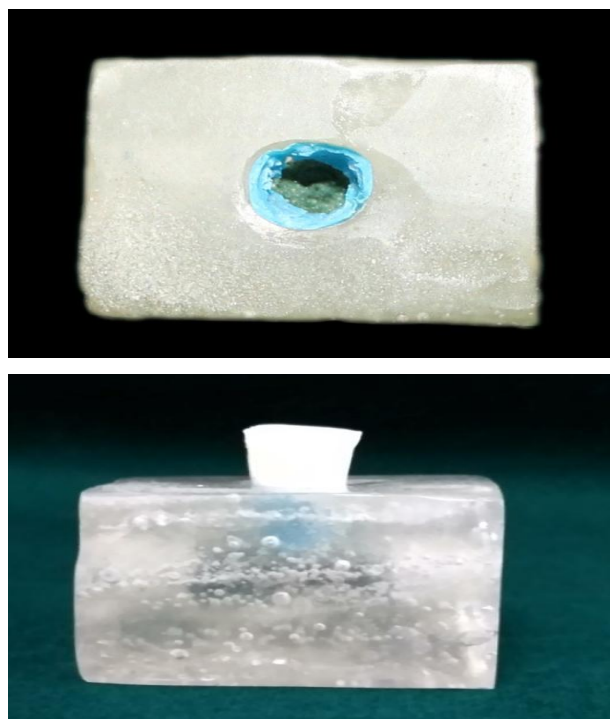


Figure 2&3: Custom made alveolus replica

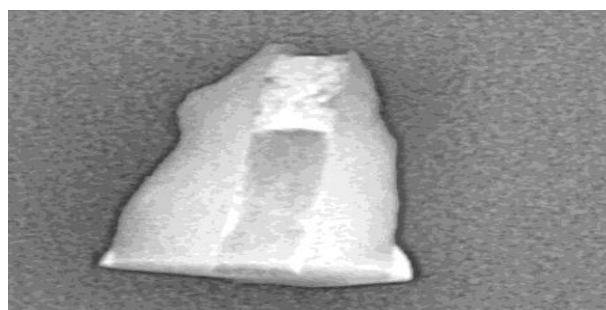


Figure 4: Shows the radiograph of Conventional method of MTA placement

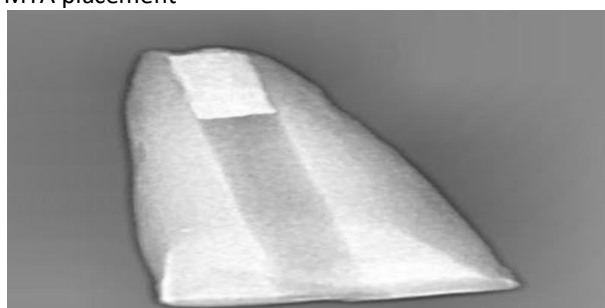


Figure 5: Shows the radiograph of Novel method of MTA placement

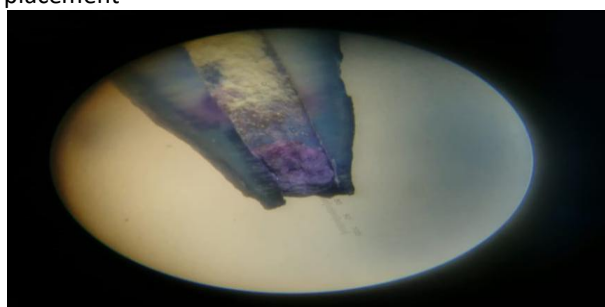


Figure 6: A stereomicroscope image (x20) of the sample from group 1 (Conventional)

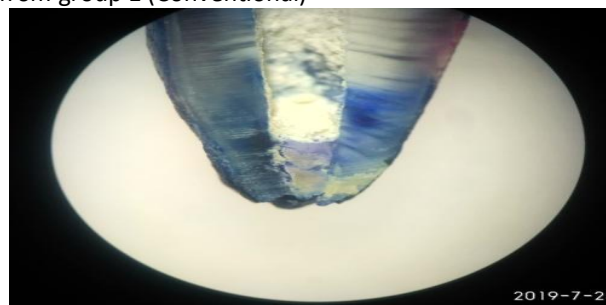


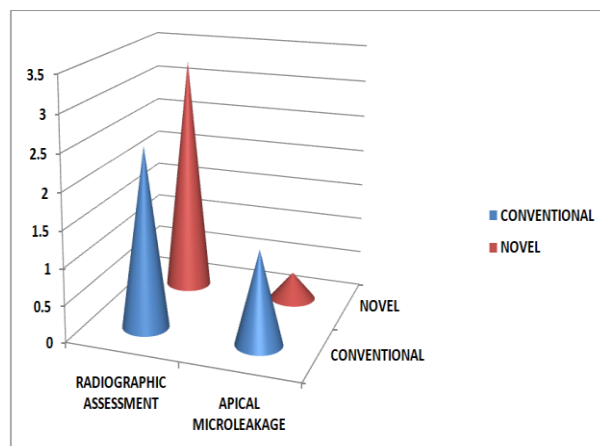
Figure 7: A stereomicroscope image (x20) of the sample from group 2 (Novel)

Table 1: Scores for radiographic assessment

Group	Score0	Score1	Score2	Score3	Score4	Mean	SD
1 [Conventional]	0	2	6	5	2	2.47	0.915
2 [Novel]	0	0	2	7	6	3.27	0.704

Table 2: Extent of dye penetration (mm)

Group	n	Minimum (mm)	Maximum (mm)	Mean (mm)	SD
1[Conventional]	15	1	1.8	1.28	0.34
2[Novel]	15	0.11	0.8	0.37	0.20

**Graph 1: Mean values of both radiographic assessment and microleakage between different groups****References:**

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