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Comparison of Micro Leakage in Root Canals Containing Separated Rotary Instruments using MTA and Biodentine Barrier – An in-vitro study

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Abstract:- Separation of an endodontic instrument in the root canal which can neither be bypassed nor removed poses the problem of apical micro-leakage leading to endodontic failure. This study aimed to compare the sealing ability of MTA and Biodentine when placed coronal to the instrument separated in the apical region of the root canal. Eighty-eight single-rooted human mandibular premolars were decoronated and were instrumented with Pro Taper Universal rotary files up to size F2. An F3 rotary file was then scratched at 3 mm from its tip with a tapered conical diamond point at high-speed to weaken and intentionally break in the canal in the apical region by binding and thereafter the roots were randomly divided into four groups (n=22). A 4mm plug of MTA or Biodentine was compacted coronal to the separated instrument and the rest of the canal was obturated with gutta-percha and AH plus resin sealer using cold lateral condensation or warm vertical compaction technique depending on the group to which the sample belonged. The dye penetration method was used to measure the apical micro leakage. Data were analyzed using one-way ANOVA test which showed a non-significant difference in micro leakage among the four groups (P> .058) as dye penetration values for all 4 groups were almost similar. The arrest of dye penetration to less than half the length of both MTA and Biodentine barrier demonstrates the good sealing ability of both the materials.

Keywords:- *Fractured instrument; Biodentine; Gutta Percha; Microleakage; Mineral Trioxide Aggregate.*

I. INTRODUCTION

The principal purpose of endodontic treatment is the absolute sealing of root canals after comprehensive cleaning and shaping. Nevertheless, this objective can be imperilled by the presence of a fractured instrument, even worse if the separation occurs before the completion of the chemo-mechanical preparation of the canal. The classical cause of endodontic treatment failure is lack of apical seal [1].

Nickel-titanium (NiTi) rotary files are favoured to shape root canals because of their super-elasticity, shape memory, and lower modulus of elasticity which facilitates effective canal preparation [1]. But the major downside of rotary NiTi files is that they fracture without any sign of previous permanent deformation [2]. The occurrence of rotary NiTi separation is 1.3%–10% in the literature, of which 44.3% is attributed to cyclic fatigue and 55.7% to torsional failure largely due to incorrect use or overuse of the instruments, and occurs typically in the apical third of a root canal [3], [4].

On instrument separation, a decision has to be made to leave, bypass, or remove the file fragment, the choice depends on an assessment of the potential gain of removal compared with the risk of complication. Removal of the separated file poses a considerable risk of sacrificing sound dentin leading to an increased threat of root perforations and root fractures, explicitly in the apical third of the root canal and so keeping the fragment unaffected should be contemplated [5], [6]. It is reported that separated instruments left in the root canal have no adverse effect on prognosis if the root canals are properly cleaned and obturated [7], [8].

Owing to its superior physiochemical, bioactive properties, and sealing abilities Mineral Trioxide Aggregate (MTA), a tricalcium silicate cement, can be used as a canal obturation material. Biodentine, a calcium silicate-based restorative cement has also been tested as canal obturation material as its compressive strength, elastic modulus, and micro hardness are comparable to that of natural dentin [9].

Separated endodontic instrument in the apical third of the root canal which can neither be bypassed nor removed poses the problem of apical micro-leakage leading to endodontic failure. Hence, there is a need to obturate the canals with biomaterials having the excellent sealing ability for the continuing success of endodontically treated root canals containing separated instruments. The null hypothesis tested was that there is no difference between the sealing abilities of MTA and Biodentine when placed coronal to the instrument separated in the apical region of the root canal.

II. MATERIALS AND METHOD

Ethical clearance to conduct the study was obtained from the college research ethics committee. Single-rooted human mandibular premolars extracted for orthodontic or periodontal reasons were collected for the study A sample size of eighty-eight teeth was selected for the present study as suggested by the statistician, determined using the mean and SD values from the literature.

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A. Selection of the Teeth

The teeth collected were cleaned off the calculus and soft tissue deposits using a hand scaler and disinfected by immersing in 5.25% sodium hypochlorite for 1 hour. The teeth were radio graphed to evaluate the internal anatomy, calcification, internal resorption, or previous endodontic treatment and also assessed for cracks, fracture, or external resorption using dental loupes of 3.0X magnification followed by storing in 0.9% normal saline at room temperature until the experiment. The study was commenced only after the total required samples were collected.

B. Standardization of samples

All the teeth were de-coronated to obtain a final length of 17+/- 0.2mm with a carborundum disk mounted on a contra-angled hand piece and were measured using a digital Vernier caliper. Preoperative radiographs in both buccolingual and mesiodistal directions were evaluated.

C. Preparation of the samples

The canal orifices were refined with an Endo-access bur and high-speed air-rotor. Patency was determined with a no.10 K file (Mani Inc, Tochigi, Japan) until it was just distinct at the apex and 1mm was decreased to establish the working length. The apical preparation was done until the size 20 K file. Thereafter, the canals were prepared with Pro Taper Universal rotary file system(Dentsply Maillefer, Ballaigues, Switzerland) up to size F2 with torque control motor (X-Smart, Dentsply Mallifer) in the crown down technique till working length and F3, 1.5 mm short of working length. Canals were intermittently irrigated throughout instrumentation with 5.25% sodium hypochlorite between each instrument using a syringe and a 27 gauge side vented needle. At the end of mechanical preparation the canals were irrigated with 5 ml 5.25% sodium hypochlorite followed by 1 ml 17% EDTA solution and 5 ml of saline. An F3 rotary file was then weakened at 3 mm from its tip with a tapered conical diamond point at high-speed to weaken and intentionally break in the canal in the apical region by binding. The roots were radio graphed to confirm the apical position of the fractured file tip. Teeth with file separation at any region other than the apical third were withdrawn. The samples were then randomly divided into four groups with 22 samples in each group.

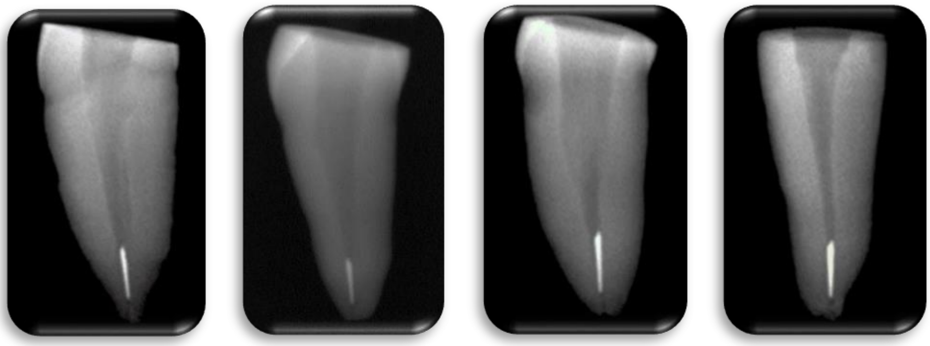

Fig. 1: Radiographic image of the broken file in the apical part of root canal

D. Grouping of samples

- **GROUP I: MTA plug + cold lateral condensation (CLC) of Guttapercha.**
  MTA was placed in the canals and compacted to make a 4mm plug coronal to the separated instrument followed by obturation of root canals with gutta-percha and AH plus sealer using cold lateral condensation technique.
- **GROUP II: MTA plug + warm vertical condensation (WVC) of Guttapercha.**
  MTA was placed in the canals and compacted to make a 4mm plug coronal to the separated instrument followed by obturation of root canals with guttapercha and AH plus sealer using warm vertical condensation technique.
- **GROUP III: Biodentine + cold lateral condensation (CLC) of Guttapercha.**
  Biodentine was placed in the canals and compacted to make a 4mm plug coronal to the separated instrument followed by obturation of root canals with gutta-percha and AH plus sealer using cold lateral condensation technique.
- **GROUP IV: Biodentine + warm vertical condensation (WVC) of Guttapercha.**
  Biodentine was placed in the canals and compacted to make a 4mm plug coronal to the separated instrument followed by obturation of root canals with guttapercha and AH plus sealer using warm vertical condensation technique.

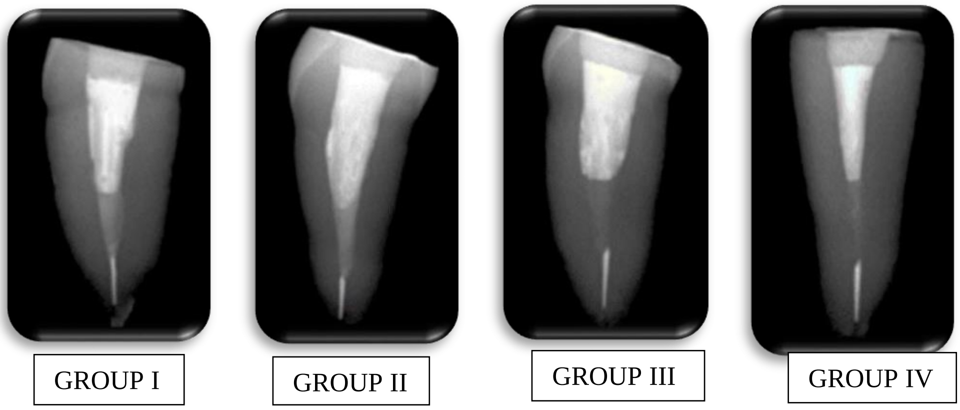

Fig. 2: Radiographic image of root canal filling material over the separated file in the root canal

E. Evaluation of the samples

The roots were radio graphed to inspect the homogeneity of obturating material and were stored at 37°C and 100% humidity for one week for the sealer to set completely. The roots, coated with nail varnish up to 2mm around the apex were immersed in India ink for 48hrs. The roots were then rinsed and sectioned mesiodistally with a carborundum disk. A stereomicroscope was used to evaluate the sections under 40X magnification by the two observers and a digital caliper was used to measure the dye penetration. The reading of each sample was tabulated and data collected were statistically analyzed.

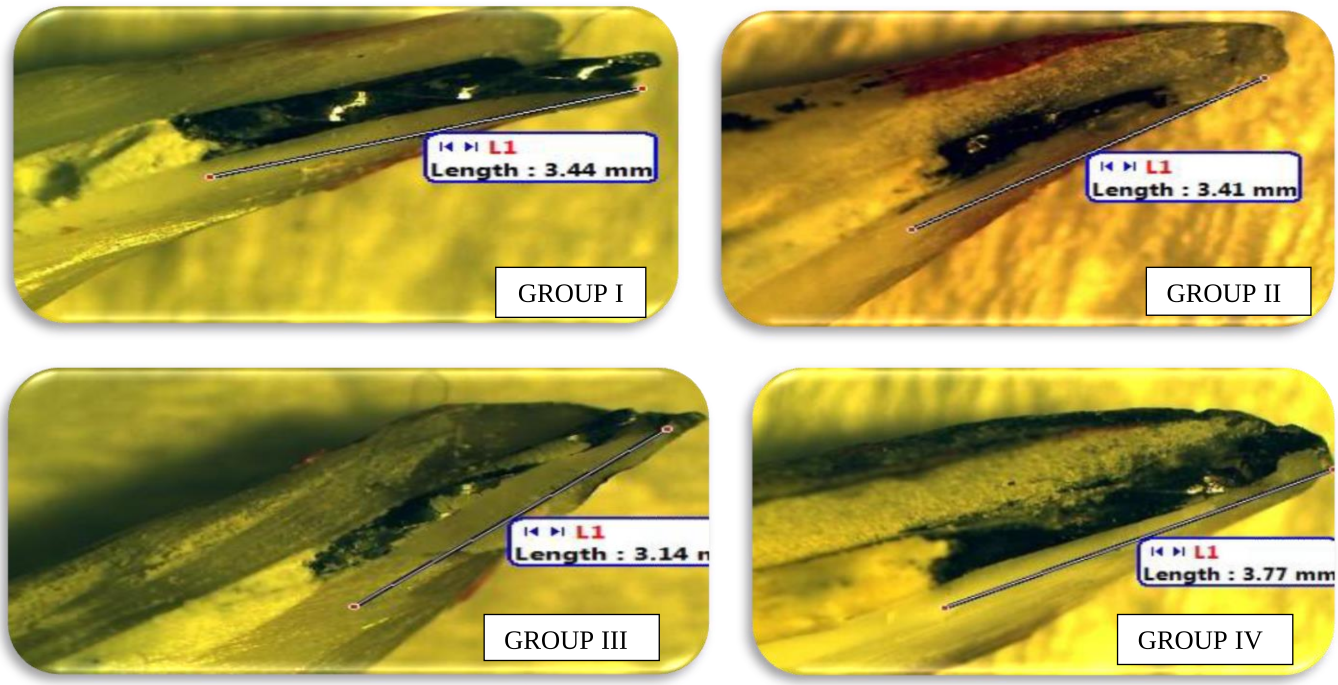

Fig. 3: Measurement of dye penetration depth under a stereomicroscope

III. RESULTS

The mean and standard deviation of dye penetration depth were recorded. The normal distribution of data was assessed using the Shapiro-Wilk test. The micro leakage among the groups were compared using one-way ANOVA. The mean dye penetration depth (indicative of micro leakage) for Group I (**MTA** with laterally condensed cold GP) was 3.5177mm, for Group II (**MTA** with vertically condensed warm GP) was 3.5573mm, for Group III(**BIODENTINE** with laterally condensed cold GP) was 3.3955mm and for Group IV (**BIODENTINE** with vertically condensed warm GP) was 3.3427mm.ANOVA showed a non-significant difference in microleakage among the four groups(P >.058) as the dye penetration values for all 4 groups were almost similar. There was no difference, whether the canal was obturated with cold lateral or warm vertical condensation as no dye penetration was evident beyond the MTA or Biodentine barrier.

IV. DISCUSSION

Eradication of enduring bacteria from the root canal system, sealing off fluid from the periapical tissues, and averting coronal microleakage are the three significant objectives of an ideal root canal filling [10], [11].Rotary NiTi instruments (separation rate - 1.3% - 10%) fracture without perceivable distortion as compared to stainless steel files (separation rate - 0.25% and 6%) which display distortion serving as an indication to looming fracture [12]. Spili et al. (2005)[8]exhibited that the presence of a preoperative periapical lesion is more significant for the healing rate rather than a fractured instrument. However, the phase of instrumentation in which the instrument fractures can affect the prognosis as cleaning and sealing the part of the canal beyond the separated instrument becomes difficult leading to the presence of continuing infection in that area [13].

This study aimed to evaluate micro leakage in root canals containing separated instruments using MTA and Biodentine barrier. The results showed a non-significant difference between the MTA and Biodentine groups and so the null hypothesis that there is no difference between the sealing abilities of MTA and Biodentine when placed coronal to the instrument separated in the apical region of the root canal was accepted.

Micro leakage was revealed in all four groups and none of the materials were able to achieve a fluid-tight seal. India ink with a molecular size close to that of bacteria was used to examine dye penetration [14].The possible reasons for theimproved sealing ability of Biodentine could be due to the development of tag-like structures when it comes in contact with dentin producing the 'mineral infiltration zone' [15].Also, the modification in the composition of the powder i.e. lack of calcium aluminate, calcium sulfate, and the addition of setting accelerators and softeners, ameliorates the physical properties including handling and sealing ability of the material [16].In addition, the density of the calcium and silicate-rich layers increases over time making it significantly larger in Biodentine contrary to other calcium silicate-based endodontic materials [17].Lesser porosity and pore volume in set Biodentine material could also be a reason for better sealing [18]. With a smaller particle size and faster setting time of 12 mins, Biodentinecon forms well to cavity surface sealing the interface faster [19].

The lesser mean values for micro leakage in the case of Biodentine in the present study are consistent with many other studies. Khandelwal*et al*.[20]in his study reported that Biodentine can take over MTA as a root-end filling material. Radeva*et al*. inferred that apical sealing with Biodentine is more efficacious when compared to MTA [21]. However, a study by Sound appan*et al*[22]proved MTA to have surpassed Biodentine, with MTA having better marginal adaptation due to the expansion of the cement on the setting. A study by Bolhari*et al*[23]revealed the comparable sealing ability of MTA and Biodentine, due to their alike composition.

Under the conditions of this study, although the two materials did not show a significant difference in preventing apical micro leakage, the ortho grade filling of the root canal system with MTA or Biodentine over the separated instrument can replace the conventional guttapercha sealer combination and extend the applications of these materials. An alternative is apical resective surgery and retrograde application of filling material to obtain an apical seal. However, due to arduous isolation of the area, contamination of the area with blood and fluids may compromise the quality of the apical seal.

In the event of reinfection, orthograderetriev ability of set MTA is troublesome, making retreatment difficult [24]. 2% carbonic acid for less than 10 minutes can be used with maximum efficacy to remove completely set MTA (after 21 days of MTA placement) with the disadvantage of reducing the micro hardness of dentin [25]. Presumably, there is a lack of substantiation on techniques and solvents used to remove set Biodentine from the canals to date. At this point, a periapical surgery with the apical third of the too thresected without invading coronally can be considered as the barrier material that prevents further ingress of periapical fluids.

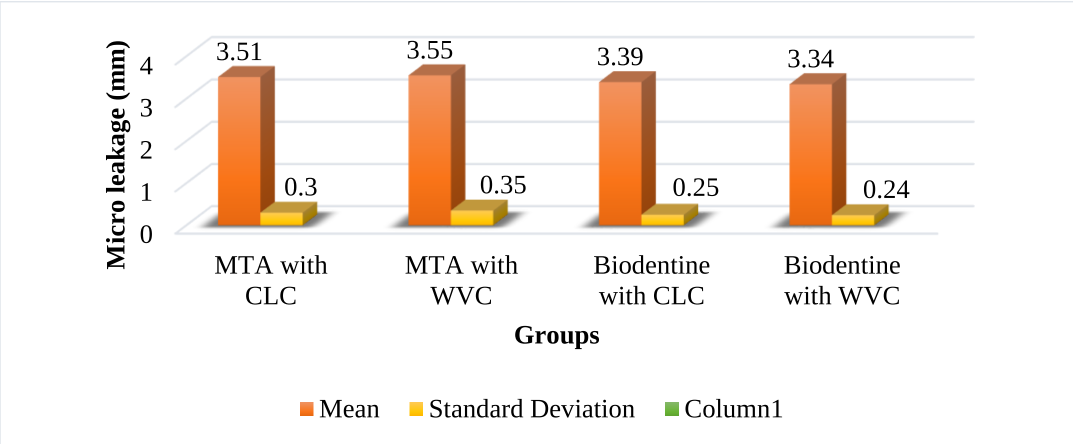

Fig. 4: The mean and standard deviation of dye penetration depth in four groups

V. CONCLUSION

Apical dye penetration was seen in all the groups which explain that separated instruments do play a pivotal role in apical leakage. The arrest of dye penetration to less than half the length of both MTA and Biodentine barrier demonstrates the good sealing ability of both the materials. With comparable sealing abilities, any of the 2 materials, MTA or Biodentine can be used in the canals further depending on their handling properties, setting time, and cost. If the endodontic treatment fails due to contamination of the periapex by any residual irritants within the root canal, resection of the apical third sansorthograde retreatment is curative.

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