The Apical Barrier Technique In A "Dens In Dente"

Literature Review and Endodontic Case Report

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Hermetic sealing of the apical foramen or foramina, which is achieved by the introduction of an obturating material into the root canal which is then thoroughly compacted, is essential to a successful outcome in endodontic therapy. The first requisite for proper root canal obturation is the development of a continuously tapering conical form, with cross sectional diameters progressively diminishing in a corono-apical direction. This can be easily achieved in mature permanent teeth in which there is an apical constriction and the canal tends to be wider coronally than apically.

The use of Mineral Trioxide Aggregate can be considered the therapy of choice for both direct pulp capping and the treatment of pulpless teeth with immature apices. The results are predictable, and the entire procedure can be completed in only 2 visits.

In contrast, teeth with immature apices do not have this apical constriction; instead, the apex is very wide. The canal walls can be parallel or even diverge corono-apically, depending on the degree of maturity. In the latter, so-called "blunderbuss" canal, the apex is even wider than the widest portion of the canal, so that its shape is exactly the opposite of what is required.

Clearly, for a tooth that is not fully mature, it is not possible to compact any type of canal obturating material into the root canal without an excess of obturating material being expressed beyond the apex. Therefore, when as a result of caries or trauma endodontic therapy of a tooth with an immature apex becomes necessary, prior to undertaking routine therapy the clinician must stimulate the maturation of the apex or the formation of a "matrix" against which the obturating material can be compacted in the traditional manner. In the case of an immature apex and necrotic pulp, the treatment is referred to as "apexification," with the objective being the induction of a calcific barrier at the open apex against which conventional obturating materials may be condensed without overfilling.[1]

This technique was first described in 1966 by Frank.[2] He recommended reducing as much as possible the contaminants present within the root canal by precise instrumentation and canal irrigations, and temporarily fill-

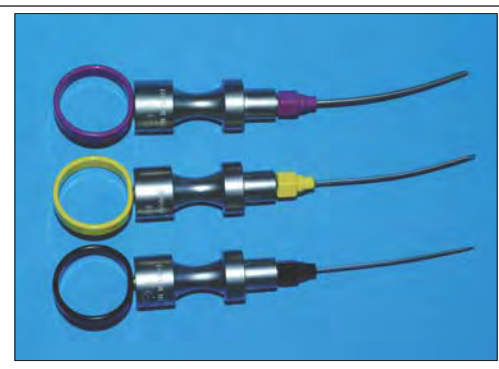


Figure 1. The Dovgan carriers, specifically designed for placement of MTA (Quality Aspirators).

Figure 2. Clinical view of the crown of the maxillary right central incisor.

Figure 3. Preoperative radiograph. Note the periapical radiolucency, the unusual anatomy, and the wide open apex.

Figure 4. The main (central) root canal has been medicated with calcium hydroxide.

Figure 5. The calcium hydroxide has been removed and a thin layer of MTA has been used for the direct pulp capping of the pulp exposure of the distal canal.

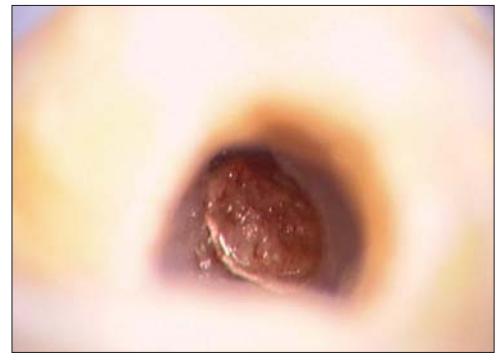


Figure 6. The apical foramen as seen through the operating microscope (20x).

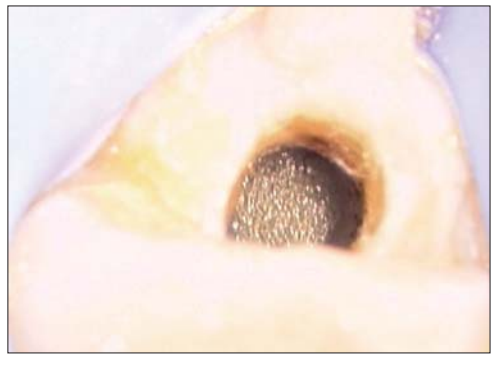


Figure 7. Three millimeters of MTA have been placed in the apical one third of the canal.

Figure 8. Intraoperative radiograph. Note the thickness of MTA without any overfilling.

Figure 9. The wet paper point is positioned in contact with the MTA.

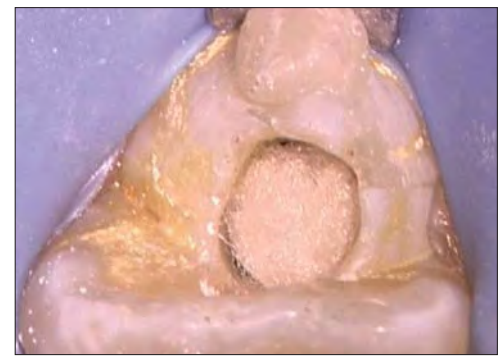
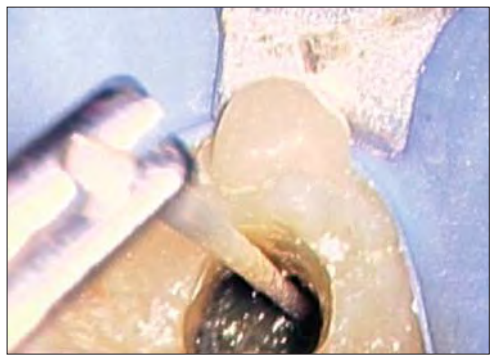
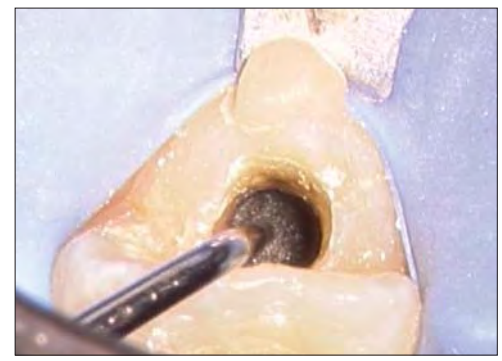


Figure 10. A wet cotton pellet is used in the pulp chamber before sealing the access cavity with Cavit.





Figures 11a and 11b. At the next visit the hardness of MTA is checked with a paper point (a) and with an endodontic probe (b).

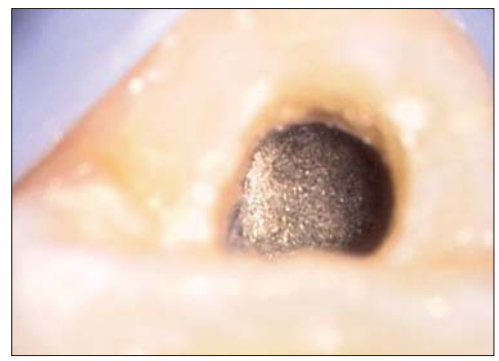


Figure 12. The MTA after setting (20x).

ing the endodontic space with a resorbable paste such as calcium hydroxide. Removing the source of infection can help promote apical closure. Once the apical barrier has formed, these canals can be obturated with conventional obturating techniques.

Despite the clinical success of the calcium hydroxide apexification technique, there are some disadvantages.[3] More than one type of apical closure can occur, depending on the vitality and presence of the Hertwig epithelial root sheath, and closure is unpredictable because when initiating treatment the presence or condition of the root sheath is unknown.[3] The time necessary to achieve the final result is sometimes lengthy. One study found mean barrier formation times ranging from 2 to 54 months[4], and another study found that barrier formation may require up to 24 months.[5] Further, if an adult patient requires closure of a tooth apex, the desired result may not be achieved. The treatment requires multiple appointments for reapplication of calcium hydroxide, or to verify its presence inside the root canal, and the time interval between visits is at least 3 months. This may result in the loss of the coronal seal, consequent recontamination, and exposure of the healing tissues to bacteria. An acute exacerbation and delayed healing may occur.[2]

For these reasons, clinicians attempted to obturate the teeth with open apices without inducing a natural apical barrier. The concept of obturating teeth with immature apices without first acquiring a natural apical barrier is not new. Several investigators[6-9] have shown that success is attainable without first inducing an apical barrier with repeated applications of calcium hydroxide. On the other hand, the predictability of treatment time necessary for induced apical closure in pulpless teeth in humans has not been established.[10,11]

The apex should be viewed as a dynamic region, capable of self repair.[8,12] Occasional instances of continued root growth and apical closure in the presence of a radiographically evident periapical rarefaction are explained on the basis of vital tissue remnants.[13] A procedure that requires multiple appointments involving frequent dressing changes and instrumentation may tend to cause injury to tissue rather than healing. Tissue within and coronal to a calcifying barrier is irritated by both the dressing changes and the final filling procedure.[14,15]

For all reasons cited above, and considering the studies by Koenigs[16] and Roberts, et al[11] on the potential benefits of tricalcium phosphate, Coviello and Brilliant[17] suggested a one-appointment procedure for obturating permanent teeth with nonvital pulps and open apices. They utilized tricalcium phosphate as an immediate apical barrier against which gutta-percha could be condensed. In their study, they found no statistical difference between the multi-appointment and the one-appointment technique. They did not observe overfilling of teeth treated with the one-appointment technique. Further, the procedure was faster, fewer radiographs were required, there was less discomfort for the patient, and the results were predictable.[17]

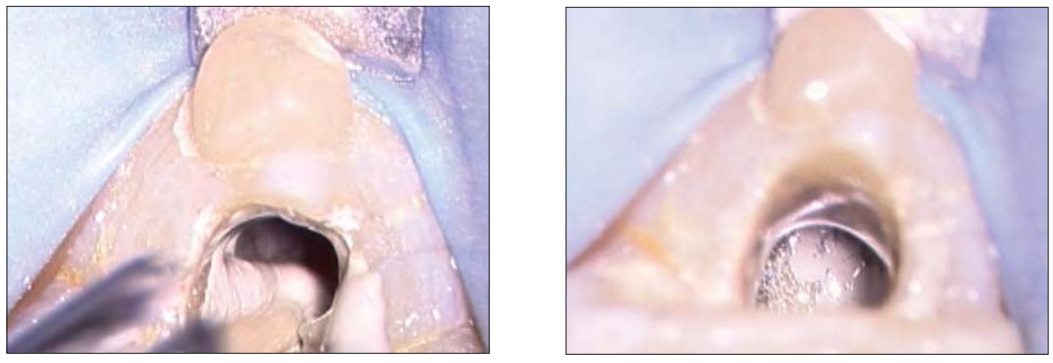
Buchanan[18] in 1996 suggested that freeze-dried demineralized bone could be packed to the end of the immature root canal to create a one-visit biocompatible apical matrix, and he reported good clinical results with this technique. The use of an operating microscope in such cases was extremely useful to visualize the canal walls down to the periapical tissues or bone graft matrix.

Recently, *Mineral Trioxide Aggregate* or MTA (ProRoot MTA, DENTSPLY Tulsa) has been introduced as an approach to obtain the formation of an apical barrier in one visit.[19] According to recent studies, when compared to calcium hydroxide and to osteogenic protein-1, MTA induces the same amount of apical hard tissue formation, without inflammation as evaluated histomorphically.[20] Studies have demonstrated newly formed bone, periodontal ligament, and cementum in direct contact with MTA.[21,22] MTA provides an apical seal which is better than what can be achieved with amalgam, IRM (Intermediate Restorative Material), and Super EBA (Ethoxybenzoic Acid, Harry J. Bosworth),[21,23-28-30,31] possesses antimicrobial properties[32], is highly biocompatible,[22,32-38] and most importantly, is hydrophilic. For these reasons, and considering the successful clinical cases reported in the literature,[5,19,39-42] MTA should be considered as the material of choice for the apical barrier technique in the treatment of pulpless teeth with open apices. (For a more complete description of the composition and properties of MTA, refer to Castellucci's "The Use of Mineral Trioxide Aggregate in Clinical and Surgical Endodontics" in *Dentistry Today*, March 2003, Vol. 22, No. 3, pages 74 to 81.)

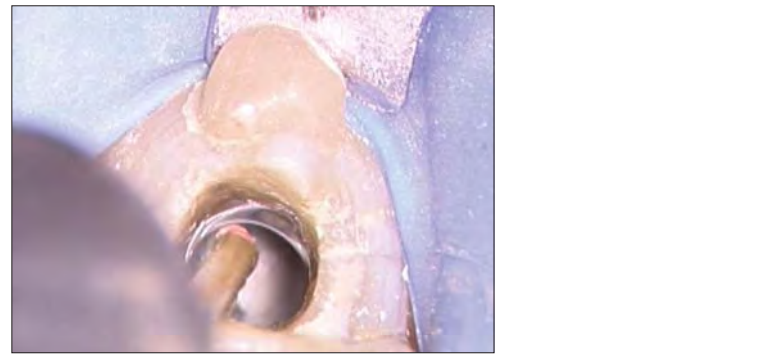
THE CLINICAL PROCEDURE

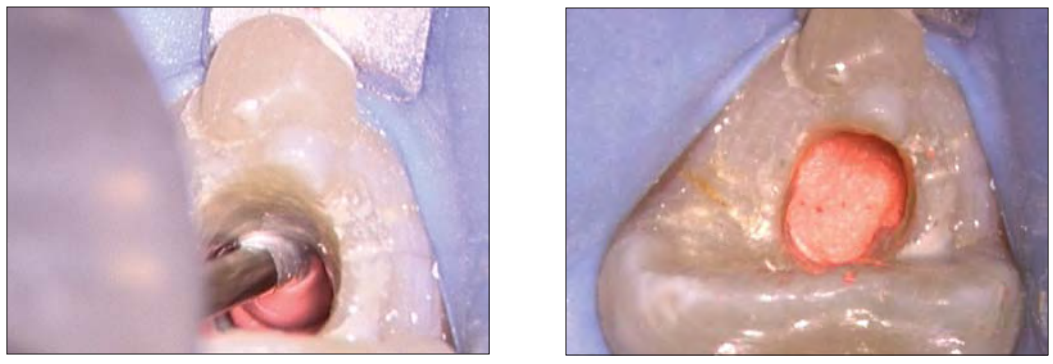
After application of the rubber dam and preparation of an adequate access cavity, the root canal system should be cleansed using copious irrigation with sodium hypochlorite. Ultrasonic instrumentation is preferred.[43,44] Teeth with immature apices need only minimum shaping. Because the canal is large and the dentinal walls are thin, they need to be cleaned more than shaped in order not to increase fragility. To improve disinfection, Torabinejad and Chivian[19] suggest using an intracanal medication with calcium hydroxide for one week.

After rinsing calcium hydroxide from the root canal with irrigation and drying with paper points, the MTA powder is mixed with saline solution or sterile water and carried to the apical area with the pre-fitted Dovgan carrier (Quality Aspirators) (Figure 1). MTA must be positioned precisely at the foramen, as the material must be in direct contact with periapical tissues, without overfilling. In general, the resistance of the periapical tissues is enough to prevent overfilling. Nevertheless, there is no contraindication to the use of a resorbable matrix (eg, Collacot, Calcitek) against which MTA could be condensed. For this purpose, prefitted Schilder pluggers (Dentsply Maillefer) and paper points can be used. The thickness of the apical plug must be 3 to 4 mm. In order to prevent voids, the use of



Figures 13 a and 13b. The canal walls are coated with Kerr Pulp Canal Sealer carried with a paper point.





Figures 14 a to 14c. The canal is obturated with thermoplastic gutta-percha.

ultrasonic instrumentation is suggested. To accomplish this, while lightly condensing the MTA with the plugger, the dental assistant is asked to touch the plugger with the ultrasonic tip. The extension of the apical plug is then verified radiographically.

If the apical plug of MTA is not satisfactory at the first attempt, the MTA is removed by irrigating the canal with saline, and the above steps are repeated. When the radiographic appearance is ideal, a wet paper point is placed in direct contact with the MTA and the access cavity is closed with a temporary seal to allow the material to set for the required 3 to 4 hours.

At the next visit (which can be the next day or the next week), the rubber dam is placed, the temporary seal and paper point are removed, and the hardness of the material is assessed first with a paper point and then with an endodontic explorer. Endodontic therapy is then completed, filling the rest of the root canal with warm gutta-percha. If the canal walls appear to be thin and fragile, it has been suggested that the remainder of the root canal should be completely filled with adhesive composite resin (without using gutta-percha)[3] or with the adhesive material Resilon (Resilon Research LLCC)[45-47] to strengthen the root.

The use of the operating microscope is essential to correctly perform the entire procedure. Furthermore, to facilitate the positioning of the material, it may be easier to carry the unmixed powder instead of the mixed material to the apex. By touching the powder with a wet paper point, MTA will absorb the necessary moisture via capillary action.

The apical barrier technique with MTA is indicated in adult patients with pulpless teeth and immature apices. For these patients, using the traditional calcium hydroxide technique is not recommended, since in general no apical calcific barrier will develop after the age of 15 to 18. Older patients are often busy and have aesthetic demands, which may result in a situation where the traditional technique with calcium hydroxide is even more contraindicated.

CASE REPORT

A 9-year-old female presented with an acute alveolar abscess of the maxillary right central incisor. There was a large swelling in the periapical area, and clinical inspection revealed the presence of unusual coronal anatomy (Figure 2). Radiographically, the tooth appeared to be a "dens in dente" with an immature open apex and a lesion surrounding the apex (Figure 3).

At the first visit the main canal of the tooth was opened and the access cavity was prepared. The tooth was then left open for drainage. Three days later the swelling and symptoms had disappeared and the tooth was medicated temporarily with calcium hydroxide (Figure 4). One week later the calcium hydroxide was removed and an attempt was made to clean and shape the narrow canals that were mesial and distal to the main canal. Based on the assumption that the pulp was completely necrotic, the orifice of the distal canal was exposed without any anesthesia, and immediately the patient felt pain, and some hemorrhage was noted. It was evident that the bur had created an exposure of vital pulp tissue. After irrigation with saline, the bleeding stopped and the pulp exposure was treated with a direct pulp capping using a thin layer of MTA (Figure 5), as suggested by Torabinejad and Chivian.[19]

During the same visit, 3 mm of MTA were positioned at the foramen (Figures 6 to 8) with the pre-fitted Dovgan Carrier, and a moistened paper point was sealed in the canal (Figures 9 and 10). Two days later the wet paper point was removed and the set of MTA was checked first with a dry paper point and then with an endodontic explorer (Figures 11 and 12). The canal walls where then coated with Kerr Pulp Canal Sealer (Figure 13) and the canal was obturated with thermoplastic gutta-percha (Obtura II) (Figures 14 and 15).

At the 2-year recall the radiograph indicated complete healing (Figure 16). The periapical lesion had completely disappeared, a lamina dura surrounded the open apex, and the pulp in the mesial and distal canals appeared vital since the tooth responded within normal limits to thermal and electric pulp tests.

CONCLUSION

The use of MTA can be considered the therapy of choice for both direct pulp capping and the treatment of pulpless teeth with immature apices. The results are predictable,[20] and the entire procedure can be completed in only 2 visits. The use of the operating microscope improves efficiency and precision.✦

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Figure 15. Postoperative radiograph.

Figure 16. Two-year recall.

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