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Perforation repair and one-step apexification procedures

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As with any dental treatment, procedural mishaps can occur during root canal therapy. One such occurrence is the perforation of a root or pulpal floor. When this occurs, the most important step is to seal this perforation as quickly as possible, avoiding potential contamination from surrounding tissues. If the perforation occurs in a general dentist's office, the dentist should contact the local endodontist and request perforation repair on that same day. After a perforation occurs, the goals are to "sterilize" (decontaminate) the site and then seal the perforation. The material most widely used in endodontics to seal perforations is mineral trioxide aggregate (MTA; Dentsply Dental,York, Pennsylvania). MTA is extremely biocompatible, and it has been shown histologically that osteoidlike material grows right into MTA [1].

Before placing MTA over a perforation site, the area should be copiously irrigated with sodium hypochlorite. This irrigant is the one most commonly used in endodontics and will help to clean the site.

Full-strength sodium hypochlorite is 5%, but most practitioners use a diluted form that is mixed with approximately 50% water. The diluted solution of sodium hypochlorite is as effective as the full-strength solution for cleansing, with less potential toxicity.

After the perforation site has been "soaked" with sodium hypochlorite for approximately 5 minutes, hemostasis and a barrier must now be achieved. Even though MTA sets in the presence of moisture, as dry a site as possible should first be established because MTA (when mixed into a "sandy" slurry) is difficult to manipulate and to place. A physical barrier must be achieved at the perforation site to prevent MTA from being packed into the bone or through the pulpal floor into the furcation site.

To achieve hemostasis and a physical barrier, there are several materials available, including various collagen-type materials such as collatape

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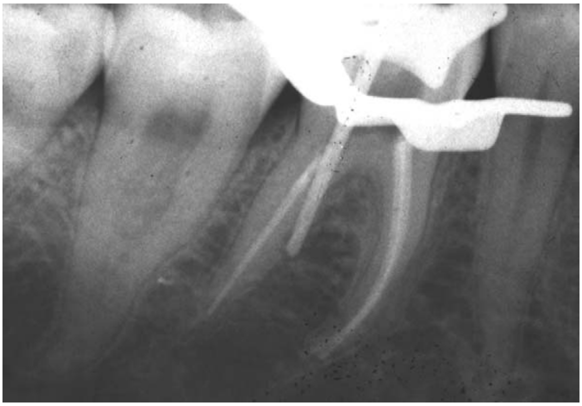

Fig. 1. Perforation made with an overly aggressive post system.

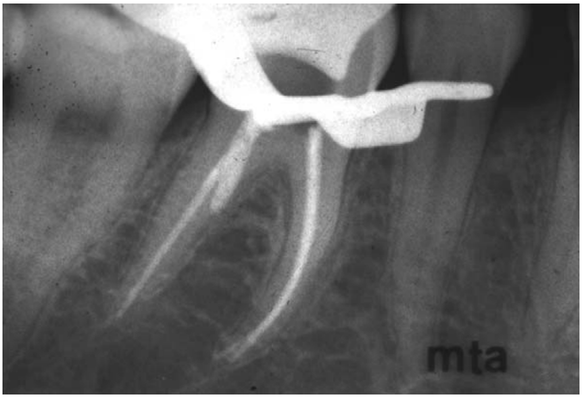

Fig. 2. Perforation sealed same day with calcium sulfate and MTA.

Fig. 3. Three-year follow-up.

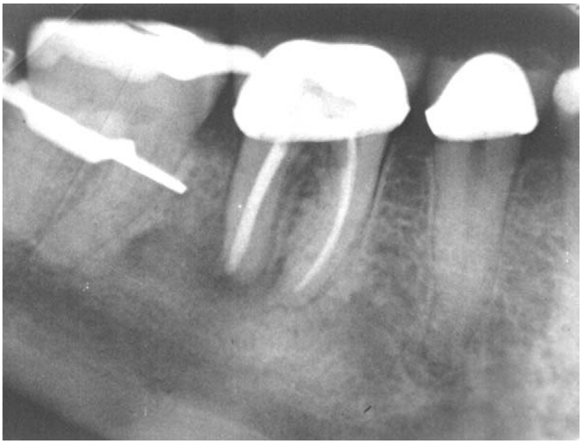

Fig. 4. Old furcation perforation that was not sealed.

(Centerpulse Dental, Carlsbad, California) and calcium sulfate (Class Implant, Rome, Italy). These materials are resorbable and are needed to help create a dry field and a solid area against which the operator packs MTA. This procedure is best performed under a surgical operating microscope that provides great magnification and illumination [2]. The microscope allows for precision in sealing these perforation sites. If choosing calcium sulfate as a barrier, only a small amount of material is required and the working time is fairly short. The calcium sulfate powder is mixed with a liquid that is packaged together, and while in a pastelike form, it can be placed through the perforation site using an S-Kondenser (Obtura/Spartan,

Fig. 5. Four-year follow-up after perforation repair.

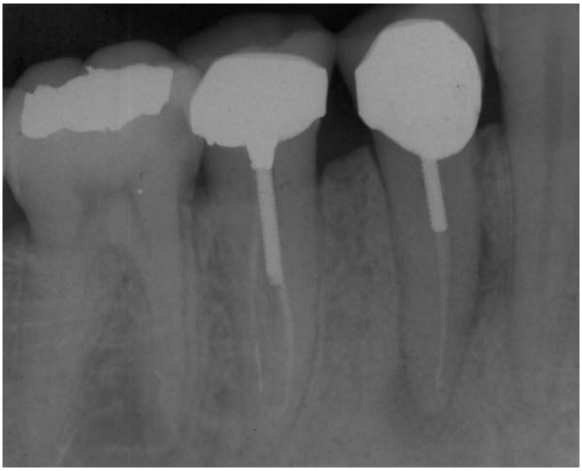

Fig. 6. Lateral lesion associated with perforation of mandibular bicuspid.

Fenton, Missouri). The S-Kondensers come in three sizes and are double-ended, with one side made of stainless steel and the other end made of nickel–titanium. The proper sized S-Kondenser is chosen before the calcium sulfate is mixed, depending on the size of the perforation. After placement, the calcium sulfate will set over the next minute or so to a stonelike consistency. The barrier is now in place and MTA is ready to be placed.

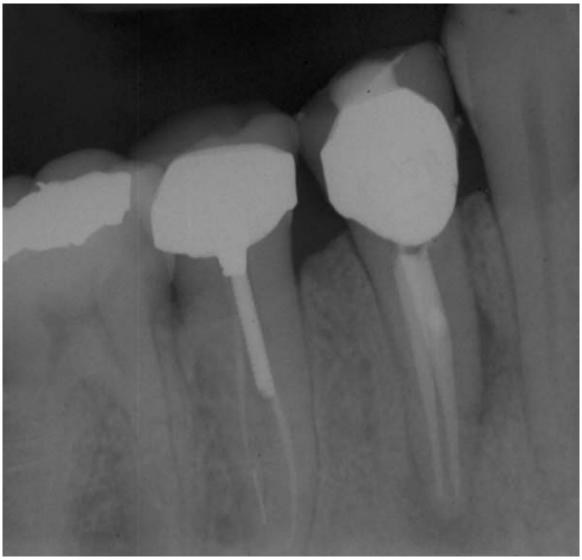

Fig. 7. Repair with collatape and MTA.

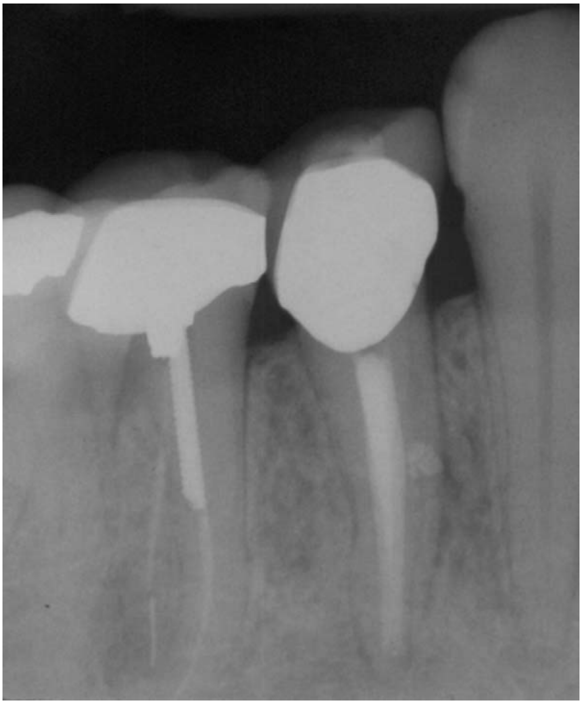

Fig. 8. One-year follow-up.

MTA has a much longer working time than calcium sulfate and if it appears too dry, it can simply be rehydrated with sterile water or anesthetic solution. Originally, MTA powder was gray in color and when mixed, looked like sand and hardened to a concretelike consistency. When sealing a perforation in the cervical portion of an anterior tooth, this gray MTA was not esthetic. Therefore, MTA is now white and the manufacturer claims there are no changes in the physical properties, but mixing it tends to be a bit more technique sensitive. White MTA is creamier when mixed and a little more difficult to manipulate but sets as hard as the original, gray MTA. MTA is placed using the S-Kondensers and abuts to the barrier that is already in place. MTA sets in the presence of moisture, so the recommendation is to place a moist cotton pellet on top of the MTA and to fill the access with a temporary filling material (eg, cavit; ESPE, Norristown, Pennsylvania). MTA will set over the next several hours under the moist cotton pellet, so at the next appointment, when the tooth is accessed, MTA will be fully set and the tooth can be permanently restored. There can be additional problems when a perforation occurs, in that it can prevent renegotiating the canal if the perforation is in the canal or very close. In these cases, it is paramount to try to keep the canal patent and

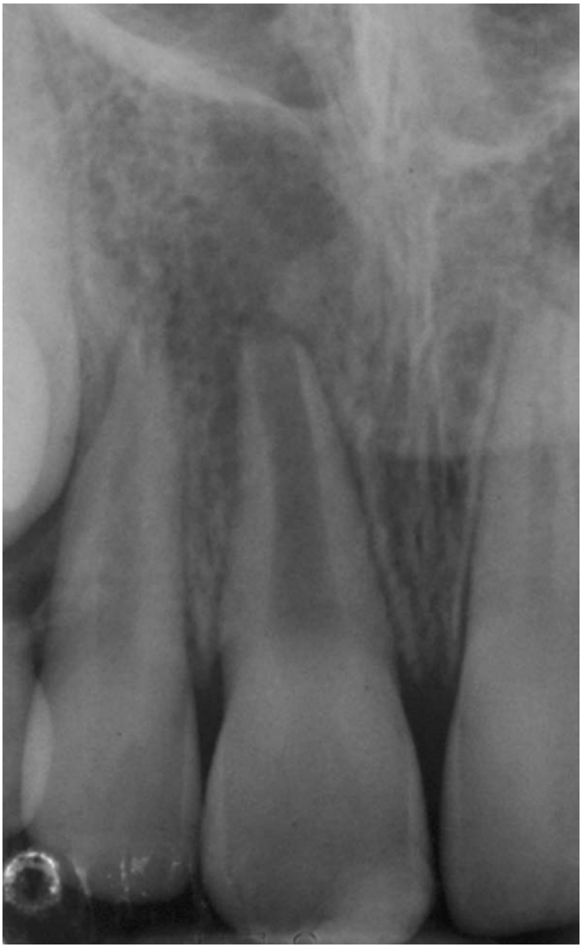

Fig. 9. Maxillary incisor with open apex.

perhaps leave a file or paper point in the canal while using MTA so as not to block the canal.

Clinical cases

Case 1

Perforation made with an overly aggressive post bur [3] (Figs. 1–3). This perforation was sealed almost immediately, using a barrier of calcium sulfate and MTA. The 3-year follow-up shows no signs of bone loss in the furcation and no clinical depth greater than 2 mm.

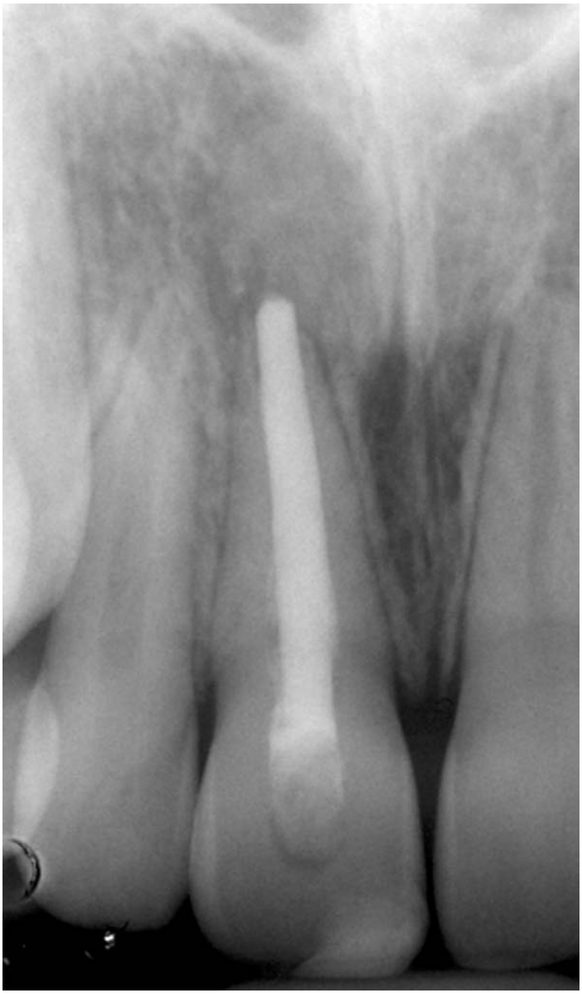

Fig. 10. Calcium sulfate placed as an apical barrier and obturated with gutta percha.

Case 2

Perforation occurred during retreatment by one endodontist and was referred to a second endodontist after several weeks (Figs. 4 and 5). This perforation was through the pulpal floor, and this situation along with the amount of time between the perforation occurring and being sealed (allowing for contamination) decreased the prognosis for this case [4]. The aforementioned technique was performed, using calcium sulfate as a barrier and MTA to seal the perforation. The follow-up radiograph shows that this case was successful, with furcal bone intact and no periodontal probing depth greater than 2 mm.

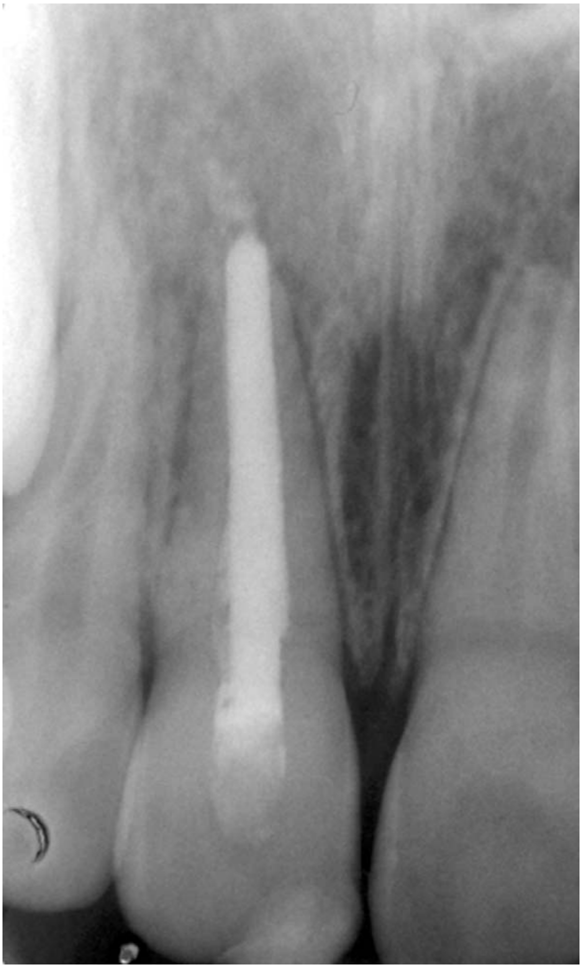

Fig. 11. One-year follow-up.

Case 3

Retreatment case of a mandibular bicuspid with an existing perforation from the first endodontic treatment that most likely occurred while the practitioner was looking for an additional canal (Figs. 6–8).

The preoperative radiograph for the retreatment shows bone loss on the lateral side of the root due to the perforation and shows a periapical lesion due to the fact that an untreated canal existed [5]. What makes this case even more challenging is that while sealing the perforation on the lateral side of the root in the midroot region, the clinician must be careful not to block the

Fig. 12. Maxillary incisor with blunderbuss apex and thin walls.

canal with the barrier material, especially because there is also a second canal that needs to be negotiated for the first time. For this reason, collatape was chosen as the barrier material, which can more easily be manipulated and packed through the perforation while maintaining the patency of the canals. Collatape comes in strips of "collagen-type" material that the clinician folds into a small piece and, with the S-Kondensers, packs it through the perforation site into the surrounding bony space. This collagen membrane resorbs, so it is acceptable to be extruding into the surrounding bone/tissues of a tooth. The missed canal was located after the gutta percha was removed from the other canal and both canals were treated. While in the process of warm vertical obturation, the gutta percha was removed

Fig. 13. Physical barrier of calcium sulfate beyond apex and MTA in apical third of canal.

apical to the perforation site, making room to pack the collatape out through the perforation, and then a layer of MTA was placed to seal off the site and the other canals were obturated with warm gutta percha. A 1-year radiographic follow-up shows healing of both the periapical and the lateral lesions, with no periodontal probing depth greater than 2 mm.

One-step apexification

Another use for the barrier/MTA technique is for one-step apexification cases. In the past, cases with open apices were often treated over several

Fig. 14. Gutta percha obturating remainder of canal.

appointments, using intracanal medicaments, with the hope of creating a ‘‘calcific’’ barrier against which gutta percha could eventually be placed. The treatment could be as long as a year, with still no establishment of any apical barrier formation. These roots were often thinner and, therefore, more brittle; extending treatment over a long period of time without providing a permanent restoration increased the chances of losing these teeth due to fracture. Similar to the technique described previously for sealing perforations, the aforementioned materials can be used to create an apical barrier and to safely obturate theses canals without worrying about extruding gutta percha into the apical tissues. Calcium sulfate and MTA are

Fig. 15. Two-year follow-up.

placed using either an amalgam carrier or the flat end of a Glick condenser and packed down the canal with S-Kondensers and using the last size file (ie, size 100 to 140 K file) so as to better gauge the depth of the calcium sulfate/ MTA placement by moving the rubber stopper down the file coronally as more material is placed in the canal. After MTA is firmly packed, the rest of the canal can be easily filled using the Obtura II (Obtura/Spartan, Fenton, Missouri), with vertical compaction of warm gutta percha. Before the advent of warm vertical condensation, filling cases such as these would be time-consuming, require an entire pack of accessory gutta percha points, and still often end up with voids.

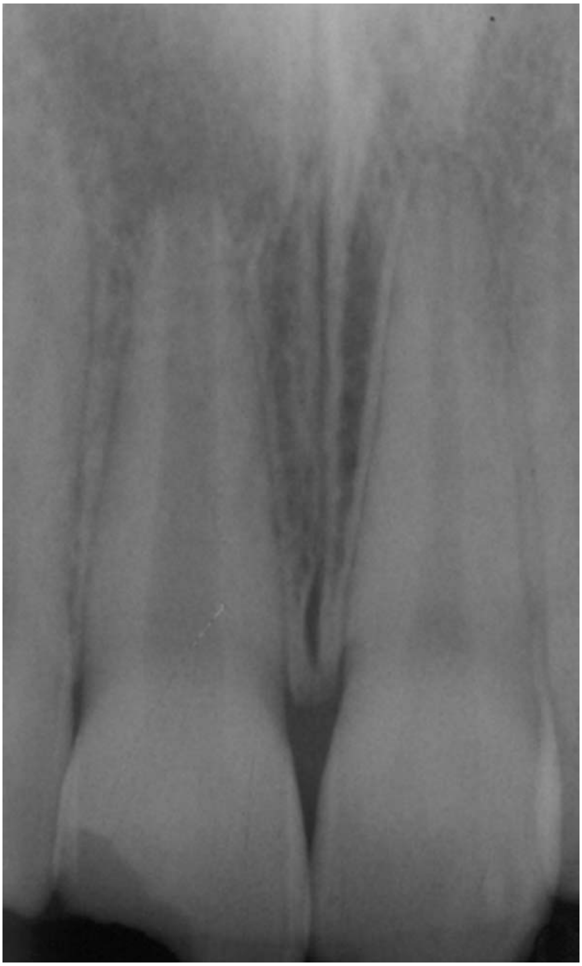

Fig. 16. Maxillary incisor with open apex.

Clinical cases

Case 4

Figs. 9–11 show a maxillary central incisor with an open apex in which calcium sulfate was placed and a firm apical stop manufactured. Instead of MTA in this case, a master cone of gutta percha was placed with tug back, confirmed radiographically, and then completed by removing all but the apical 5 mm of gutta percha using the System B heat transfer unit (Sybron Endo, Orange, California) and backfilling with the Obtura II. A 1-year radiographic follow-up shows intact periapical bone and no sign of pathology.

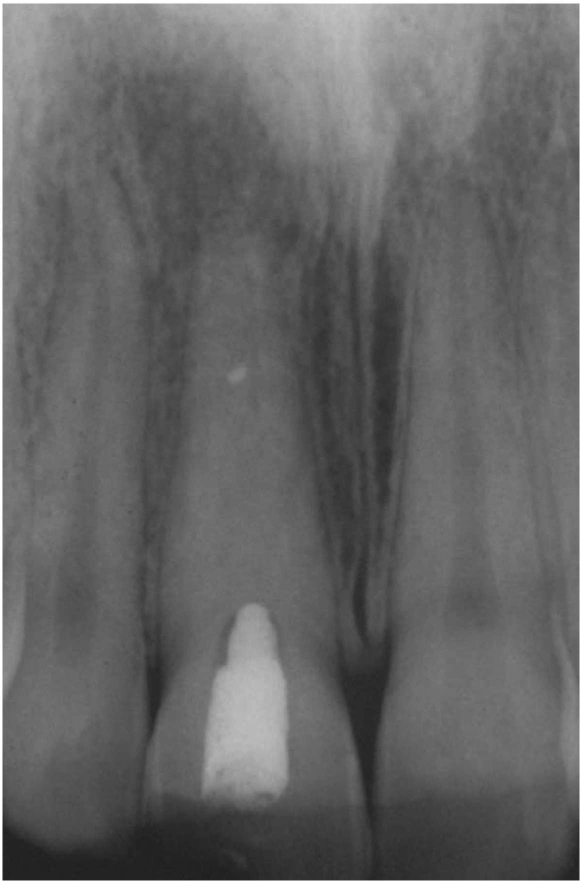

Fig. 17. Canal filled with calcium hydroxide to attempt apexification.

Case 5

Figs. 12–15 show a maxillary central incisor with a blunderbuss apex and thinner walls than the previous case. A small periapical lesion is present. To create a barrier, calcium sulfate was placed apically, extruding into the periapical area but forming a physical barrier against which MTA can be packed at the root end. MTA fills the apical 3 mm of the canal, and the rest of the canal is obturated with warm gutta percha [6]. An often-asked question is, Why not fill the entire canal with MTA? There is really no benefit to doing this because MTA is much more expensive and more time-consuming to place than gutta percha. Radiographic follow-ups at 2 years show complete healing periapically and no pathologic signs.

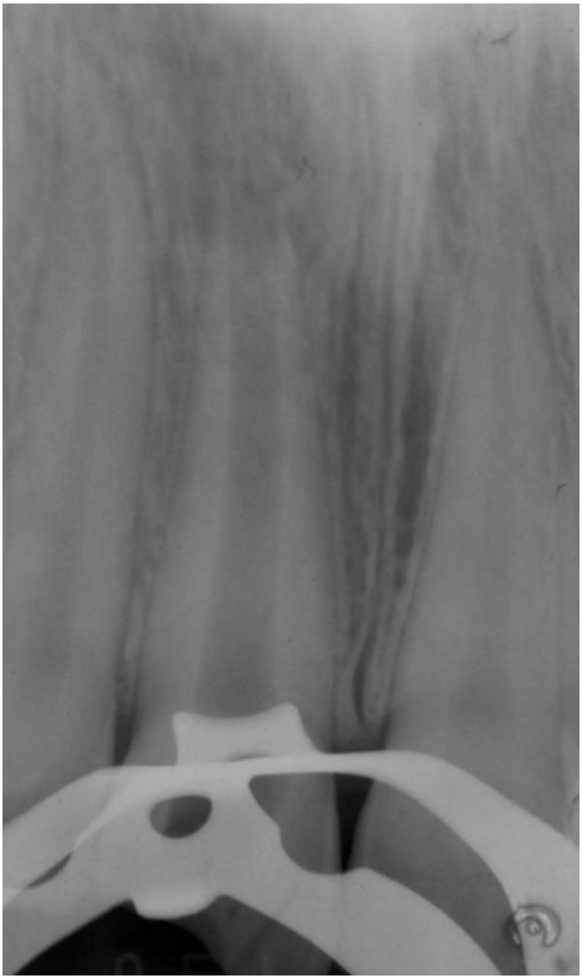

Fig. 18. After several placements of calcium hydroxide, still no calcific barrier apically.

Case 6

Maxillary central incisor with an open apex in which apexification was originally attempted by multiple calcium hydroxide placements [7] (Figs. 16–19). After this failed attempt to create a calcific barrier, the one-step apexification technique was performed, using calcium sulfate and MTA. A radiograph confirms the calcium sulfate in place (sealing off the apical tip of the root), MTA in the apical few millimeters of the canal, and the final gutta percha placement. A slight demarcation can be seen between MTA and gutta percha, but the radiopacity is almost identical.

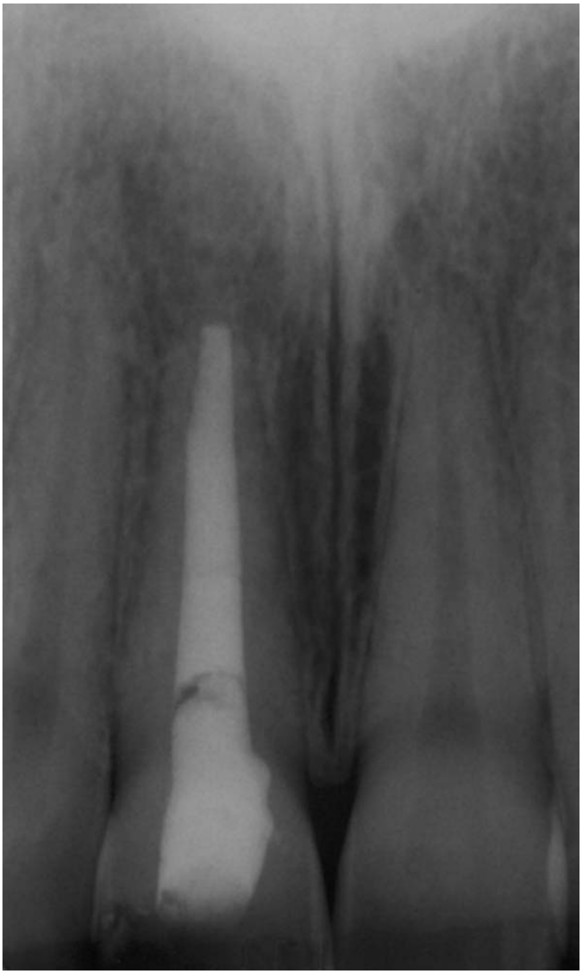

Fig. 19. One-step apexification with calcium sulfate, MTA, and gutta percha.

This technique of one-step apexification offers an alternative to those drawn-out cases with several medicament-changing appointments that often resulted in a failed attempt at root-end closure. With the favorable histologic response of MTA, this material is the best current choice for this procedure [8]. Completion of these cases in an effective and efficient way allows for permanent restorations to be done in a more timely manner, prolonging the longevity of these teeth.

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