Received: 25th December 2013 Accepted: 2nd April 2014 Conflict of Interest: None
Source of Support: Nil

Case Report

Role of Cone Beam Computed Tomography and White Mineral Trioxide Aggregate in the Successful Management of a Permanent Anterior Tooth with Open Apex

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How to cite the article:
Shekhar V, Arora R, Roy M. Role of cone beam computed tomography and white mineral trioxide aggregate in the successful management of a permanent anterior tooth with open apex. J Int Oral Health 2014;6(4):68-72.

Abstract:
Cone beam computed tomography (CBCT) is a recent three-dimensional (3D) radiographic imaging modality used for the accurate diagnosis, management and follow-up of endodontic problems. In tooth with open apex and periapical lesion, the use of new obturation material such as white mineral trioxide aggregate (wMTA) facilitates faster and more predictable closure of root apex and periapical healing. The objective of this case report was to evaluate the role of CBCT and wMTA obturation in management of a permanent anterior tooth with open apex and periapical lesion. After CBCT evaluation of maxillary left central incisor with open apex and periapical lesion, it was endodontically treated with wMTA obturation. The patient was recalled regularly for 6 months. CBCT was found to be a useful tool for the diagnosis and post-operative evaluation of this case. The wMTA used for obturation in two visit endodontic treatment resulted in successful outcome, both clinically and radiographically.

Key Words: Cone beam computed tomography, open apex, periapical lesion, white mineral trioxide aggregate

Introduction

Radiographic examination is an indispensable adjunct to clinical examination in diagnosing, managing and monitoring the treatment results of various endodontic pathologic conditions such as periapical lesions. Traditionally, intraoral periapical (IOPA) radiography has been used for the assessment of various endodontic problems. At present, a recent radiographic technique that is being used is the CBCT, which are the most advanced types of digital radiography. Here, an object is exposed to multiple cone-shaped beams that travel 360° around the patient with the motion center placed in the area of interest and the X-ray detector on the opposite side of the circle. Later serial sagittal, coronal and axial section images are obtained, allowing the clinician to visualize morphologic features and pathologies from different 3D perspectives eliminating the superimposition of anatomical structures. CBCT detects not only the presence of a periapical lesion, but also their relatively true size, extent, nature and location. It is also used for the evaluation of root canal configuration, steps in endodontic treatment and re-treatment, coronal restoration, detection of bone lesions, and experimental endodontology.[1,2]

A traumatic injury or pulpal disease during the stage of root development leads to incomplete closure of the root apex (open apex) of the tooth.[3,4] A periapical lesion may be associated with such an open apex tooth having blunderbuss canal, as it is more prone to bacterial infection leading to necrosis of the pulp tissue and an inflammatory response in the periapical tissues.[5,6] It presents with various clinical and radiographic signs and symptoms such as pain, swelling, discoloration of the tooth, draining sinus tracts and periapical radiolucency.[7] Its management involves non-surgical endodontic therapy with complete disinfection and obturation of the root canal. However, the divergent anatomy of the open apex and thin root dentin walls makes it difficult to completely disinfect the canal, obtain an adequate apical seal and maintain the obturation material within confines of the canal without extrusion into the periapical area. The closure of the root apex in such teeth may be done either with the multi-visit long-term use of calcium hydroxide dressing for apexification, which could take 3-24 months or with a single-visit endodontic treatment done using mineral trioxide aggregate (MTA) as an apical barrier.[8-12]

The MTA maybe placed as apical plug followed by gutta-percha obturation or as an obturation itself. MTA has the ability to solidify in <3 h following its placement in the canal and thus can be used as an immediate obturation material in teeth with open apices.[5] Due to the high osteogentic potential of MTA, it leads to a more predictable closure of the open root apex and periapical healing due to the induction of a cementum-like hard tissue when placed adjacent to the periapical tissues in a shorter period.[13] The other favorable properties of MTA are that it completely seals the root canal system, has excellent marginal adaptation and is highly bio-compatibile, thus prevents complications in case overfilling occurs.[8-10,12,14,15]

Therefore, the aim of the following case report was to assess the role of CBCT in the diagnosis and follow-up of a permanent anterior with open apex and periapical lesion obturated using white ProRoot MTA.

Case Report

An 18-year-old healthy female patient presented with the complaint of discolored left upper front tooth. She had a history of fall 10 years back, which resulted in slight fracture of crown of the tooth but the patient was otherwise asymptomatic.

The clinical examination revealed Ellis class II fracture and discoloration in the crown of tooth 21 (Figure 1a). A sinus opening was also seen in the apical region of 21. Thermal and electric pulp vitality tests revealed that the tooth was non-vital. IOPA radiographic examination revealed presence of a blunderbuss canal having open apex in tooth 21 (Figure 1b). CBCT examination was also done, which revealed perforation present on the mesial side of tooth apex in coronal plane indicating presence of a periapical lesion (Figure 1c). CBCT image in sagittal plane revealed perforation of the tooth structure and buccal cortex in the apical region (Figure 1d). The 3D CBCT image revealed the presence of a periapical lesion associated with tooth 21 (Figure 1e). CBCT images in axial plane done at coronal, middle and apical third of the root revealed considerable increase in the diameter of the root canal at middle third and disruption of the buccal cortex at apical third region of the root (Figure 1f-h). The extent of the periapical lesion apico-occlusally and mesio-distally toward the buccal cortex and radiolucent area at the lesional site was also noted in the coronal plane of the CBCT image (Figure 1i).

Based on these findings, a diagnosis of periapical abscess and pulp necrosis associated with an open apex in tooth 21 was established. Its management by endodontic therapy with MTA obturation was planned to enable closure of the open root apex and healing of the periapical lesion. It was to be followed by non-vital bleaching and final restoration with a direct composite veneer on tooth 21.

After placing the rubber dam, an access opening was done in 21 (Figure 1j). It was followed by working length determination using IOPA radiograph (Figure 2a). Cleaning and shaping were done by circumferential filing and ultrasonic activation of 3% sodium hypochlorite. A calcium hydroxide dressing mixed with saline was placed in the canal using absorbent paper points (Figure 2b). IOPA radiograph revealed increase in the radiopacity of the canal space following calcium hydroxide placement in 21 (Figure 2c). The patient was recalled after a week, rubber dam was placed, the dressing was removed and the canal was thoroughly dried with absorbent paper points. For obturation, the white ProRoot MTA wMTA was mixed to a paste consistency with distilled water and delivered to the canal up to

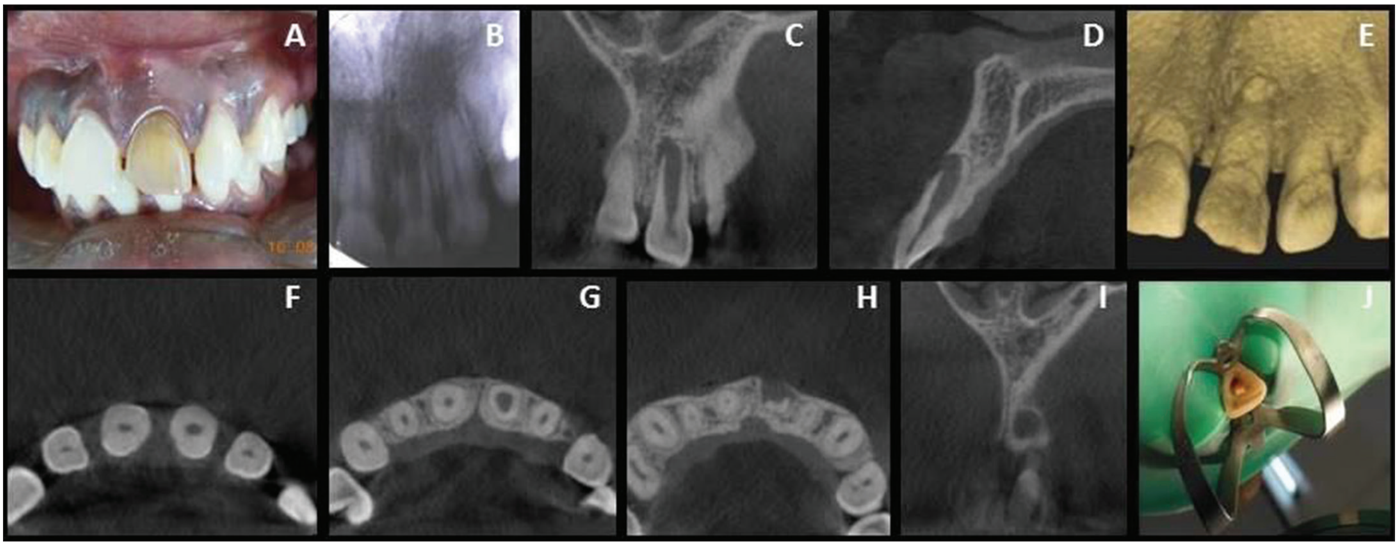

Figure 1: (a) Pre-operative photo showing crown fracture and discoloration in left maxillary central incisor and presence of sinus opening. (b) Intraoral periapical (IOPA) radiograph showing blunderbuss canal in left maxillary central incisor. (c) Pre-operative cone beam computed tomography (CBCT) image in coronal plane showing apical root perforation on mesial side indicating presence of a periapical lesion. (d) Pre-operative CBCT image in sagittal plane showing apical perforation of the root and buccal cortex. (e) Pre-operative three-dimensional (3D) CBCT image. (f) Pre-operative CBCT image in axial plane at coronal third of the root. (g) Pre-operative CBCT image in axial plane at middle third of the root showing considerable increase in the diameter of the root canal as compared to right central incisor. (h) Pre-operative CBCT image in axial plane at apical third of the root showing disruption of the buccal cortex. (i) Pre-operative CBCT image in coronal plane showing periapical lesion extent in the apico-occlusal and mesio-distal plane towards the buccal cortex. (j) Access opening done in the tooth under rubber dam isolation.

the apex using Messing gun and a hand plugger. The access cavity was temporarily sealed and post-operative IOPA radiograph revealed a homogenous compaction of the wMTA into the canal space of 21 (Figure 2d). Post-operative CBCT image in coronal, sagittal and axial plane at coronal, middle, and apical third of root showed a homogenous wMTA obturation (Figure 2e-i). A slight inadvertent extrusion wMTA was seen into the lesional space in post-operative CBCT image in coronal plane and the 3D CBCT image immediately after wMTA obturation (Figure 2j and k).

After wMTA obturation, an intra-orifice glass ionomer cement barrier was placed followed by placement of sodium perborate mixed with saline in the access cavity for intracoronal non-vital bleaching (Figure 3a and b). Temporization of the access cavity was done (Figure 3c) and patient was recalled after 1 week to replace the bleaching material for adequate lightening of the tooth. When desired lightening of color tooth was achieved and the tooth was clinically asymptomatic with healed sinus opening (Figure 3d), tooth preparation was done on 21 for direct composite veneer (Figure 3e). Then, etchant 37% phosphoric acid gel was applied for 15 s, rinsed thoroughly and dried with absorbent paper. Then, bonding agent was applied and cured for 20 s. Final restoration was done with a layer of composite, which was cured for 45 s (Figure 3f). The occlusion was carefully checked and adjusted. The patient was recalled regularly for follow-ups.

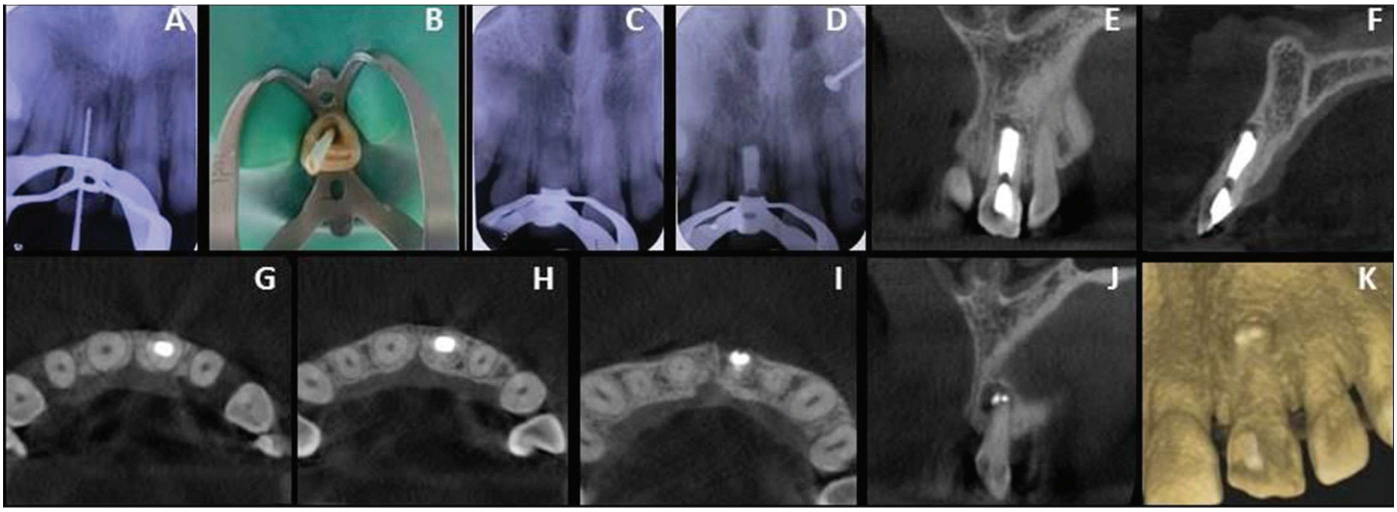

Figure 2: (a) IOPA radiograph showing working length determination. (b) Placement of calcium hydroxide in the canal with absorbent paper point. (c) IOPA radiograph showing increase in the radiopacity of the root canal space following calcium hydroxide placement in left central incisor. (d) IOPA radiograph showing obturation with mineral trioxide aggregate (MTA). (e) Post-operative CBCT image in coronal plane showing MTA obturation. (f) Post-operative CBCT image in sagittal plane showing MTA obturation. (g) Post-operative CBCT image in axial plane at coronal third of root showing MTA obturation. (h) Post-operative CBCT image in axial plane at middle third of root showing MTA obturation. (i) Post-operative CBCT image in axial plane at apical third of root showing MTA obturation. (j) Post-operative CBCT image in coronal plane showing slight extrusion of MTA into the lesional space. (k) 3D CBCT image immediately after MTA obturation showing MTA extrusion into the lesional space.

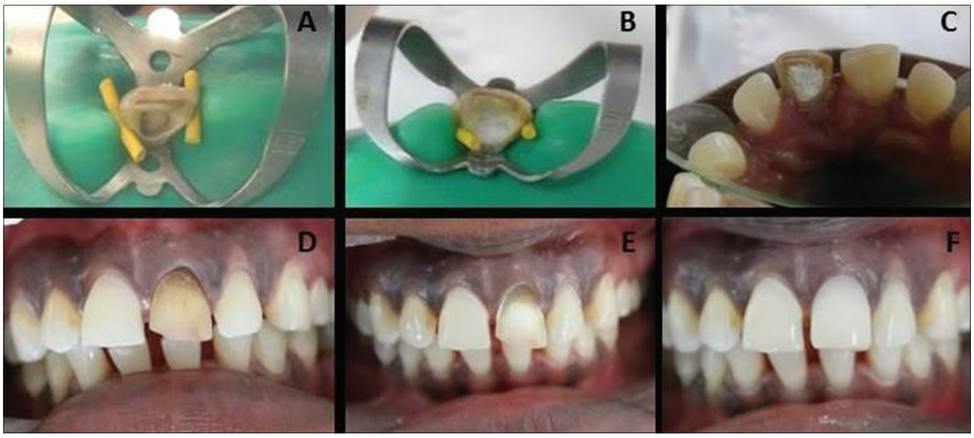

Figure 3: (a) Intraorifice GIC barrier prior to non-vital bleaching. (b) Placement of bleaching agent sodium perborate mixed with saline in the access cavity. (c) Temporization of the access cavity. (d) Lightening of tooth color following bleaching. (e) Tooth preparation for direct composite veneer. (f) Final post-endodontic restoration with composite.

The IOPA radiographs taken at 1 month and 3 months showed that the periapical radiolucency had reduced in size indicating progressive periapical healing (Figure 4a and b). CBCT examination was done at the end of 3 months in all the three planes - coronal, sagittal and axial taken at coronal, middle and apical third of the root, which again revealed healing of the periapical lesion seen as increased radiopacity (bone density) in the lesional site around the wMTA filling (Figure 4c-h). The 3D CBCT reconstruction image showed an unchanged morphology of the extruded MTA at the lesional site (Figure 4i). The status of wMTA obturation as evaluated with IOPA radiograph revealed a well compacted filling up to the apex with no voids, even after 6 months and a healed periapical area (Figure 4j). The patient was clinically asymptomatic throughout this time period. The patient is now scheduled to come for routine yearly follow-ups.

Discussion

CBCT is an excellent tool for the assessment of various endodontic challenges as it is more accurate in detection and localization of endodontic problems. It can provide additional information in three dimensions when compared to two-dimensional conventional IOPA radiography, and thus helps in the diagnosis, treatment planning, management and follow-up of cases more predictably.[1,2] In this case, both IOPA radiographs and CBCT scans were done for diagnosis, immediately after obturation and for follow-up after 3 months. CBCT images in all the three planes helped in the detection of periapical lesion during the diagnosis which was not detected by IOPA radiographs. CBCT also determined the extent, size and location of the periapical lesion accurately. The extent of wMTA extrusion into periapical area as well as the increase in periapical radiopacity suggestive of periapical healing was detected using CBCT. Thus, when IOPA radiographs and CBCT images were compared, it was observed that the CBCT images were distinctly superior in evaluation of the presence of the periapical lesion, status of MTA obturation and periapical healing in teeth with open apex.

Incomplete root development in a permanent tooth due to pulp necrosis presents with the absence of apical constriction (open apex) and thin root dentin walls.[3,6] It makes the endodontic treatment of such teeth challenging as during the procedure of canal disinfection and obturation, the materials used are likely to extrude in the periapical area.[7,9,13] When these extruded materials contact the periapical tissues, inflammatory or allergic reactions may occur. Thus, MTA is the material of choice in such cases as it biocompatible and provides an immediate homogeneous fluid-tight seal by formation of a colloidal gel, even in the presence of moisture or blood, which is present in open apex areas.[10,14] According to various studies, the superior biocompatibility of MTA to the periodontal tissues has been attributed to the production of hydroxyapatite and deposition of cellular cementum adjacent to MTA filling. This leads to the regeneration of periradicular tissues to an almost normal condition in a short time period.[5,12] MTA also has an additional advantage of faster speed of completion of therapy i.e., the endodontic treatment can be completed in a single

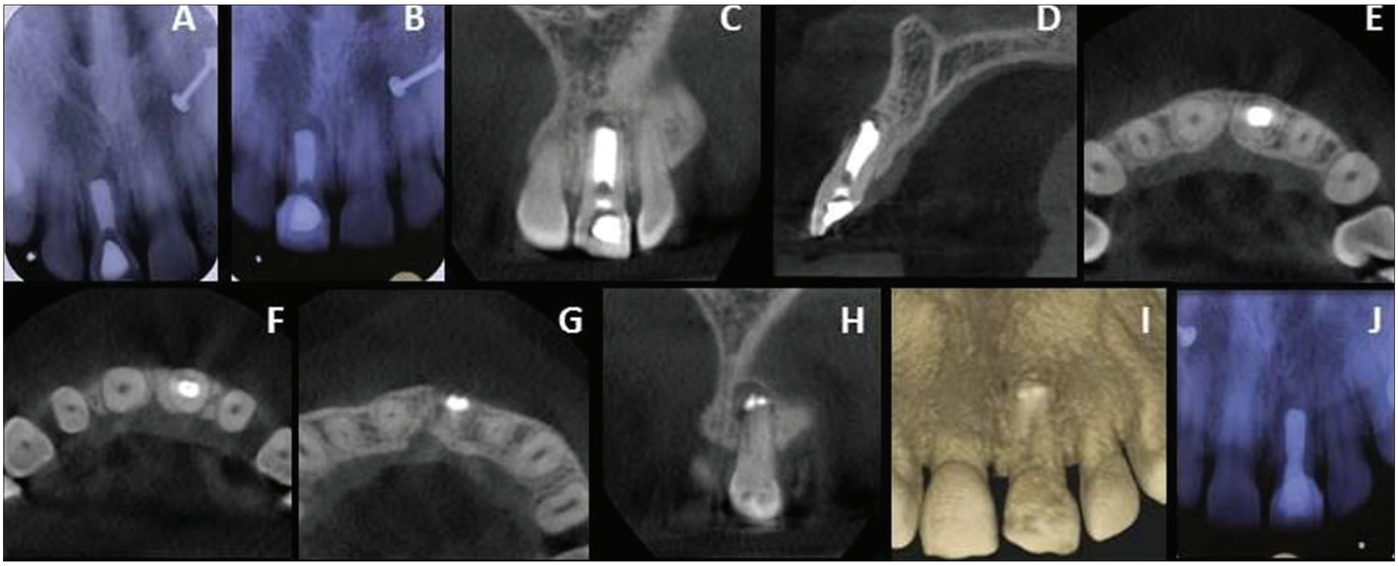

Figure 4: (a) IOPA radiograph at 1 month. (b) IOPA radiograph at 3 months showing healing of the periapical lesion. (c) CBCT image in coronal plane at 3 months. (d) CBCT image in sagittal plane at 3 months. (e) CBCT image in axial plane at coronal third of root at 3 months. (f) CBCT image in axial plane at middle third of root at 3 months. (g) CBCT image in axial plane at apical third of root at 3 months showing increased bone density in the lesional site around MTA filling. (h) CBCT image in coronal plane at 3 months showing increased radiopacity in the lesional site around MTA filling. (i) 3D CBCT image at 3 months showing unchanged morphology of the MTA filling in lesional space. (j) IOPA radiograph at the end of 6 months showing apical closure of the root and healed periapical area.

visit.[8,15] Thus, MTA leads to predictable periapical healing and the extrusion of MTA into the periapical area does not produce complications, which was confirmed with CBCT in this case. The rationale for use of a short-term calcium hydroxide dressing before final obturation with wMTA in this case was to reduce the bacterial infection as the pulp was necrotic.[3,7,9]

The final post-endodontic restoration was done in this case by a conservative approach. Initially, non-vital bleaching was done to lighten the dark color of the tooth. Finally, a direct composite veneer was done to achieve the proper form, function and esthetics of the tooth. The follow-up was done for a period of 6 months. CBCT and IOPA radiographic examination revealed a decrease in the size of the periapical radiolucency and increased radiodensity around wMTA filling over this period. Thus, a favorable treatment outcome was seen when wMTA was used as the obturation material in a tooth with open apex, regardless of the presence of a periapical lesion, which is comparable with similar previously reported successful cases of apexification by MTA apical plugs.[8,14]

Conclusions

CBCT was found to be useful for the diagnosis, management and post-operative evaluation of a case involving a permanent anterior tooth with open apex and periapical lesion. The wMTA was found to be an excellent obturation material for endodontic treatment in such a case resulting in successful treatment outcome, both clinically and radiographically, after follow-up period of 6 months.

Acknowledgment

The authors acknowledge the support of Dr. Praveen Shrinivas (Secretary, Hazaribagh College of Dental Sciences and Hospital, Hazaribagh) with the publication of this article.

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