Chronic Sinusitis of Odontogenic Origin Due to an Undiagnosed Displaced Root Fragment in the Maxillary Sinus and the Role of Cone Beam Computed Tomography in Successful Management

Abstract
Radiographic imaging is an important criterion in diagnosis, treatment planning, and follow-up of an endodontic treatment. When clinicians encounter with diagnostic difficulties and persistent symptoms, the need for advanced diagnostic aids, especially imaging methods, become imperative and essential. This paper reports a case, in which primary endodontic therapy having failed, the patient had persisting symptoms such as pain, swelling, and draining sinus along with signs and symptoms of maxillary sinusitis. Advanced diagnostic aids such as Cone Beam Computed Tomography was useful in an accurate identification of the etiology, which was a fractured mesiobuccal root tip of maxillary molar. This is the first reported case, in which the fractured root tip has migrated to the maxillary sinus, during primary endodontic treatment, through the perforated antral floor causing odontogenic sinusitis. The operating microscope helped in the successful completion of endodontic retreatment along with fractured root fragment retrieval.

Keywords: Cone beam computed tomography, gutta-percha, maxillary sinus, retreatment, ultrasonics

Introduction
Odontogenic sinusitis accounts for 10%–15% of maxillary sinusitis and 30%–40% of chronic maxillary sinusitis.[1] It occurs when the sinus membrane (Schneiderian membrane) is violated by conditions such as infections, trauma in the maxillary posterior teeth, pathologic lesions related to maxilla or maxillary teeth and by iatrogenic causes such as implant surgery complications, maxillofacial surgical procedures etc. Maxillary sinusitis is clinically characterized by symptoms such as bilateral nasal discharge (purulent, watery, or mucoid), sinus pain, nasal obstruction, headaches that intensify in the evenings while bending, halitosis, and occasional coughing.[2]

The anatomical relationships of maxillary sinus involve the maxillary teeth inferiorly, which facilitates the easy extension of the infectious processes from the particular teeth to the sinus.[3] The roots of the maxillary premolars and molars are situated closely below the sinus floor. The mesiobuccal (MB) root of maxillary molar is closest to the sinus with a mean distance of 1.97 mm.[4] Hence, cleaning and shaping of these teeth during endodontic procedures may predispose to iatrogenic errors such as the introduction of root canal filling materials, tooth fragments, and broken instruments into the maxillary sinus. The most common foreign body in the maxillary sinus is the displaced root or root fragments following extraction of a maxillary molar. Odontogenic foreign bodies in the sinus can be an excellent niche for the growth of fungi and bacteria, thus its removal is needed even if it is asymptomatic.[5]

Identification and localization of foreign bodies are based on history, clinical and radiographic examinations. Periapical radiographs are the primary diagnostic aid used in identifying the foreign bodies.[6] However, these are not helpful in the identification of cases, in which foreign body sizes are <2 mm or in identifying the exact locations of the objects. These problems can be overcome by advanced diagnostic and imaging aids such as Cone Beam Computed Tomography (CBCT).

Chellaswamy Savrimalai
Karumaran,
Anil Kumar
Ramachandran¹,
Remya Venkatesan¹
Department of Endodontics,
Raghav Dental Clinic,
¹Department of Conservative Dentistry and Endodontics,
Ragas Dental College,
Chennai, Tamil Nadu, India

Address for correspondence:
Dr. Chellaswamy Savrimalai
Karumaran,
Raghav Dental Clinic, No. 9,
North Gopalapuram, Second Street, Chennai - 600 086,
Tamil Nadu, India.
E-mail: maranods@yahoo.co.in
This case report presents a clinical case where an MB root tip of the maxillary molar was fractured and its subsequent migration into the maxillary sinus caused odontogenic sinusitis. The uniqueness of the case is the fracture of the root tip as a result of repeated root canal treatment, retrieval of the fractured root tip from the sinus and successful surgical retreatment of the tooth with the aid of an operating microscope.

**Case Report**

A 43-year-old male reported to the clinic with persistent pain and swelling in the left first maxillary first molar region for the past 2 months. He described his chief complaint as pain in the left cheek region, nasal discharge, and recurrent headaches along with pain beneath the eyes for the past 5 months. His dental history revealed that the patient had undergone two repeated root canal treatments on the same tooth over a period of 5 years. The medical history of the patient was noncontributory. On dental examination, the maxillary left first molar showed mild signs of gingival inflammation and the pocket depth around the tooth was normal. Tenderness to percussion was noted with intraoral swelling in the vestibule region. The Intraoral Periapical (IOPA) radiograph gave an impression of presence of periapical pathology with deficient gutta-percha in all the canals [Figure 1].

In the first visit, orthograde endodontic retreatment was initiated with the removal of the gutta-percha with the help of Protaper Retreatment files (Dentsply) from all the canals. In the palatal canal the apical 1 mm was not retrievable. Calcium hydroxide intracanal medicament (Metapex, Meta Biomed) was placed, and access cavity was restored with Intermediate Restorative Material (IRM), Dentsply. During the treatment, the patient had persistent symptoms along with a draining sinus in association with tooth #26.

In the second visit, a CBCT scan was suggested to understand the extent of the lesion, the root morphology and for planning further treatment procedures. Informed consent was obtained from the patient, and the CBCT scan was carried out. In the CBCT sections, diffused periapical radiolucency without radiopaque border and deficiency of the MB root apex in association with tooth #26 was visible [Figure 2b]. Maxillary sinus floor was deficient in the area between MB and palatal root apices [Figure 2a]. A well-defined radiopaque material of size 2 mm × 2 mm with inner radiolucency was present along the antral floor adjoining the distobuccal (DB) root apex [Figures 2c, 3b and 3c]. Considering the clinical symptoms and CBCT report, it was diagnosed as periapical abscess associated with tooth #26 with a fracture in the MB root tip, which has migrated into the maxillary sinus through the perforation in the antral floor [Figure 2d-f]. Buccal cortical plate deficiency was evident in the CBCT, which confirmed the buccal cortical plate perforation [Figure 3a and b].

In the third visit, the patient was notified regarding the fractured root tip, and then the treatment plan was formulated and finalized. After obtaining the patient’s consent, investigations and preparations for the periapical surgery were initiated. Local anesthesia was achieved using 2% Lidocaine with 1:100,000 epinephrine (Lignospan special, Septodont, France). Root canals were instrumented by Hedström files (Mani) to size 35 and irrigated with 3% sodium hypochlorite solution and 0.9% saline solution, obturation was completed by cold lateral condensation technique with 2% gutta-percha cones (Dentsply) and AH Plus (Dentsply, Tulsa, OK) as sealer [Figure 4a]. The occlusal access cavity was restored using silver amalgam.

Sulcular incisions with vertical incisions mesial to tooth #25 and distal to #27 on the buccal vestibule were placed, and a rectangular full-thickness flap was elevated. Using the operating microscope – Global G6 (Global Surgical Corporation), the surgical area involving the apical portion of the tooth and the sinus region were carefully evaluated [Figure 4b]. The apical end of MB root was broader bucco palatally and was elliptical in shape. The apical fracture of the MB root was clearly noticeable. The separated fragment was not visible as it was overshadowed by blood and the surrounding tissues. The fractured root tip was then removed by careful manipulation of the region under microscope. In order to confirm the complete removal of the foreign body, the sinus was then flushed with saline. Root end preparation was completed with

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**Figure 1**: Preoperative radiograph of tooth #26 showing deficient obturations in all root canals with periapical lesion associated with mesiobuccal root
Ultrasonic tips (Satelec) and was restored with super Ethoxy Benzoic Acid (EBA) [Figure 4c and d].

The sinus floor was visually examined before closure. The flaps were repositioned with 5-0 nylon nonresorbable interrupted sutures [Figure 4e]. Antibiotics (AMOX 500 mg), Antihistaminics (CETZINE 10 mg), and nonsteroidal anti-inflammatory drugs (Imol) were prescribed. The patient received both verbal and written routine postsurgical instructions. The patient was instructed not to blow through their nose to avoid an oroantral communication. A week after the procedure, the sutures were removed, and the surgical site was examined for any evidence of infection or oroantral communication. The patient had an uneventful healing and in 3 months a porcelain fused to metal crown was placed [Figures 5a and 4f]. The patient was followed up for 3 years, and no symptoms were reported [Figure 5b and c].

Discussion
Complete removal of potential irritant from root canal space, shaping of the canal and providing a hermetic seal of the canal space is considered as critical requirements for endodontic therapy to be successful. The success rate of primary endodontic treatment is as high as 86.02%, and that of retreatment with surgery is 63.4%.[8] Despite the high success rate of endodontic treatment, failures (10%–15%) do occur in some cases.[9] In cases, in which primary endodontic therapy fails, nonsurgical retreatment, apical surgery or extraction and immediate prosthetic or implant placement are the treatments of choice. In the present case, the patient had persistent pain and discomfort even
after the repeated nonsurgical endodontic treatments, the causes of which could be improper diagnosis or incomplete chemomechanical preparation of the canals. As a result, the patient was advised for a CBCT to diagnose the cause of the persisting symptoms and to plan for the further treatment procedures. CBCT has higher spatial resolution and greater ability to detect high-density foreign bodies as small as 0.5 mm and also helps in the localization of it.[6]

Incidentally, CBCT revealed the presence of periapical abscess associated with tooth #26 and the deficiency of buccal cortical plate associated with the same tooth. This confirmed the perforated buccal cortical plate related to tooth #26 which has been a route for approaching the MB root during the periapical surgery.

There is also evidence of deficiency of MB root apex in the form of an oblique slice, and a radiopaque irregular foreign body was found along the antral floor just above the DB root of tooth #26. The fracture of the mesiobuccal root tip was confirmed, which had eventually migrated into the maxillary sinus through a breach in the antral floor and facilitated by the cilia of the lining epithelium of the maxilla. The diagnostic accuracy of periapical radiographs is less due to various factors such as image distortion, the overlap of surrounding anatomical landmarks, as it is a two-dimensional depiction of three dimensional structure and the inability to pick up very small objects.[10]

The possible reasons for the fracture of the root tip could be; first, the MB root of tooth #26 was broader than usual in the IOPA which would have given a misconception in the presence of more than one canal. Second, CBCT revealed lateral apical exit of the MB canal which was not identified in the routine radiographs taken. The former and the latter reasons have led to the possible unnecessary preparation of the concerned root. The presence of lateral exit of the canal also explains the location of the fractured apical tip of the MB root which was adjoining the DB root apex. Third, repeated root canal treatments including cleaning, shaping, lateral and vertical condensations could have induced high load on the root apex and also the force applied during gutta-percha retrieval. The mean load on the root apex during lateral condensation, that can fracture the
root of maxillary molar is 11.5 kg. Fourth, patient's age is related to the root fracture, with a majority present above the age of 40 years. In the present case report, the age of the patient was 45 years which can be another cause for the fracture of the MB root tip of maxillary molar.

The odontogenic sinusitis presented in this case report requires a combined conservative and surgical treatment. Specific considerations are applicable during periapical surgery of the maxillary molar and premolar also referred to as antral teeth. This includes careful manipulation of the maxillary sinus wall or floor, avoidance of sinus membrane perforation and care to prevent the introduction of foreign bodies within the maxillary sinus. The periapical surgery is performed with the aid of an operating microscope, which permits a conservative, retrograde preparation of root end using ultrasonic tips and a precise retrograde filling with super EBA. Thus, an apical and coronal seal was achieved.

The size of the foreign body was small; the presence of buccal perforation and with the help of CBCT and the operating microscope, a minimal invasive approach along with the periapical surgery is undertaken. The advantages of a minimally invasive approach to removal of the foreign body are: decreased pain, bleeding, and swelling, which are the immediate benefits and the long-term benefits including minimal bone damage, reduced risk of vital structure involvement, and better healing.[12]

**Conclusion**

Detailed knowledge about the root canal system and proper diagnosis along with well planned and executed treatment procedures pave the way for a successful endodontic treatment. Endodontic therapy performed with the aid of modern technology is a predictable treatment. Modern technologies used in endodontics such as CBCT and operating microscopes have established themselves a useful tools in visualization and assessment of the endodontic pathologies leading to precise and effective treatment, thereby rendering superior care to the patient. Knowledge about these technologies will help clinicians to make full use of these excellent systems, starting from diagnosis to treatment outcome.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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