

Teeth in the maxillary sinus – imaging and management

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Abstract

Purpose To evaluate the images obtained by CT in diagnosis and treatment plan of teeth in the maxillary sinus.

Methods Twelve patients with teeth in the maxillary sinus were studied by plain film radiography (PFR) and by CT with a dental software programme, which displays multiple panoramic and cross-sectional views of the mandible and maxilla. The three-dimensional morphology of the tooth, its inclination, proximity to the sinus wall, surgical planning and prediction of prognosis and complications were estimated on both PFR and on CT scans and scored.

Results The radiographical features interpreted from PFR were fair or poorly diagnosed whereas CT provided excellent features. The surgical approach of choice was based on CT interpretation.

Conclusion CT is useful for diagnosis and treatment planning of teeth in the maxillary antrum.

Key words: Maxillary sinus, tooth, abnormalities; Tomography scanners, X-ray computed

Introduction

The maxillary sinus, located in the body of the maxilla, is the largest of the paranasal sinuses. The floor of the maxillary sinus is formed by the alveolar process of the maxilla and is intimately related to the teeth of the upper jaw, ranging from a minimum of the first and second molars to a maximum of all the teeth with the exception of the incisors. At birth the antral cavity measures about 3 mm in diameter. With an increase in age the diameter of the sinus increases owing to the development of the surrounding facial skeleton. During adult life the sinus may continue to expand to a varying degree. If a tooth is extracted, especially during the early years of adult life, the sinus may extend down into the alveolar process, and may even approximate the alveolar crest of the maxilla.

The apices of the teeth are separated from the floor by bone of varying thicknesses, and sometimes the sinus mucosa lies between the root of the tooth and the sinus cavity (Alberti, 1976; Fireman and Noyek, 1976).

Teeth in the maxillary sinus are rare. However, it may be associated with one of three distinct processes: developmental disturbance, pathological process and iatrogenic activity (Delbalso, 1990). Due to its rarity, the literature that deals with this entity is scarce and most of it is case reports (Jones and Steel, 1969; Von Wowern, 1971; Ehre, 1980; Amaratunga,

1986; Awang, 1988; Punwutikikoru *et al.*, 1994). We are unaware of any comprehensive study on the assessment of teeth in the maxillary sinus or evaluation of the treatment modalities.

The present article is a retrospective study of the clinical features of a group of 12 patients with teeth in the maxillary sinus and an evaluation of the advantage of CT to the diagnosis and surgical management.

Materials and methods

During a six-year period, 12 patients with impacted teeth, were admitted with various suggested problems involving the maxillary sinus. There were three patients with developmental disturbances, four patients with pathologic process and five patients following an iatrogenic activity. A thorough clinical examination and plain film radiography (= PFR), such as Waters view, panoramic, occlusal and periapical radiographs, were insufficient to establish a precise diagnosis or treatment plan.

CT scans were carried out using an Elite 2400 Scanner (Elscent Co., Haifa, Israel) with a dental CT software program (Denta Scan™, GE Medical, Milwaukee, WI, USA) (Bodner *et al.*, 1993; Yanagisewa *et al.*, 1993; Bodner *et al.*, 1995; Krennmair and Lenglinger, 1995). Scans were operated on at 120 kVp and 65 mAs. Overlapping 1.2 mm axial cuts were obtained through the maxilla

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Accepted for publication: 30 June 1997.

or the mandible, at 1 mm intervals. Images were then reconstructed into cross-sectional (bucco-lingual) and panoramic views based on the axial scans without additional exposure of the patient. The ratio of 1:1 was used to obtain precise measurements using rulers directly on the films.

The following parameters were evaluated: three-dimensional morphology of the tooth, its inclination, proximity of the tooth to one of the sinus walls, surgical planning and prediction of prognosis and complication.

These were estimated on both PFR and CT scans by the same investigator for each criterion. Data for the two types of images were scored as excellent (+++), good (+++), fair (++), or poor (+) as previously described (Bodner *et al.*, 1993; Bodner *et al.*, 1994). The images were blindly and independently read by all the authors. Differences were resolved by consensus. Data was tested for differences between the two types of images PFR and CT with the 'sign test'.

Case reports

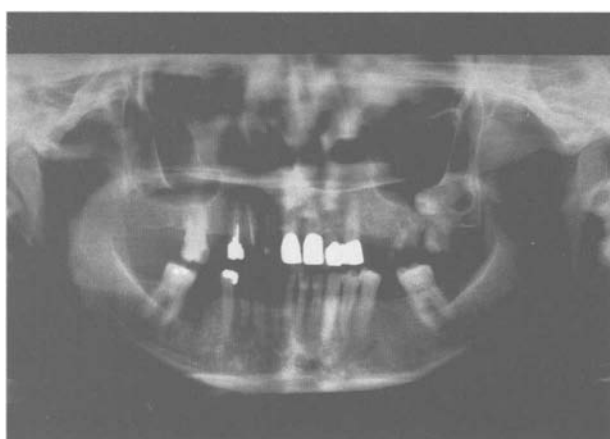
Case 1

An impacted third molar was located inside the left maxillary antrum (Figure 1). A 51-year-old female was referred for evaluation of an asymptomatic radiopaque mass superimposing the left

maxillary antrum. Panoramic (Figure 1a) radiograph for routine dental treatment revealed a tooth-like structure apical to the roots of the first and second molars, with differential diagnosis of a third molar tooth (#28) inside the antrum. Axial CT scan (Figure 1b) revealed that the tooth was inside the antrum. Using the dental CT software programme, bucco-lingual slices were reconstructed, based on the axial images, without additional exposures of the patient (Figure 1c). The bucco-lingual images further demonstrated that the tooth was inside the antrum, but also revealed that the crown was in proximity to the floor of the sinus, whereas the root was more closely related to the posterior wall. In addition, no bony ankylosis of the tooth to the sinus wall was seen, which is an important factor if extraction is to be considered. Also, the height of the alveolar process between the crown of the impacted tooth and the roots of teeth #26 and #27 was estimated to be 3–4 mm, enough to prevent the complication of oroantral communication. Using a crestal incision, tooth #28 was removed from the sinus floor without difficulties.

Case 2

This was a dentigerous cyst of the right maxillary sinus (Figure 2). A 25-year-old male presented with



(a)



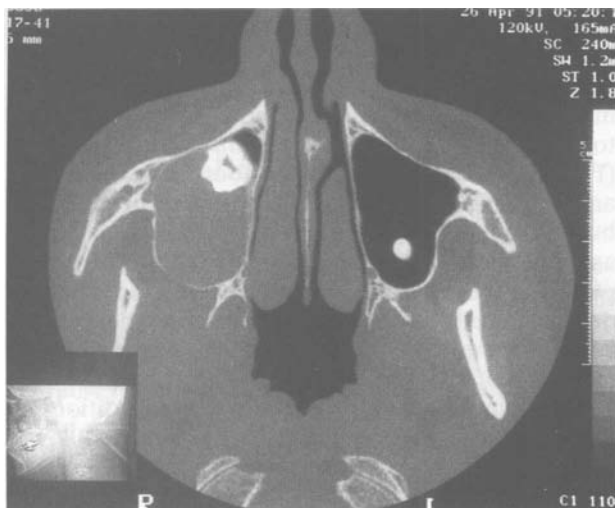
(c)



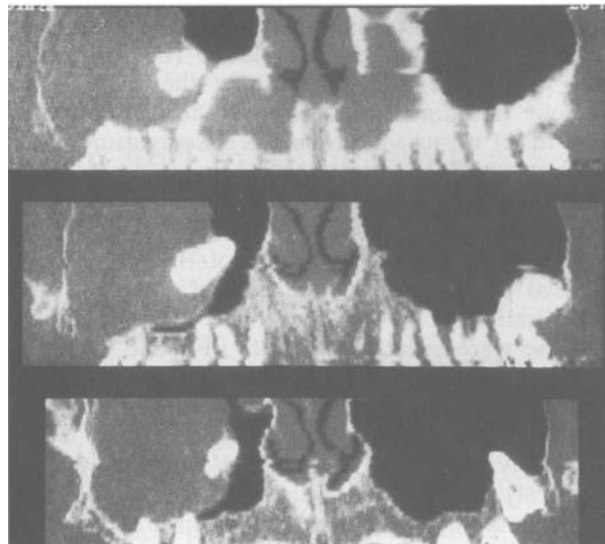
(b)

FIG. 1

A third molar developed inside the left maxillary sinus. (a) Panoramic radiograph shows a tooth-like structure apical to the roots of first and second molars. The bucco-lingual localization is unclear. (b) Axial CT scan reveals that the tooth is located inside the antrum. (c) CT reconstruction of the maxilla at the bucco-lingual plane, further demonstrates that the tooth is inside the antrum, but also reveals that the crown is proximal to the floor and the root is close to the posterior wall of the sinus. No bony ankylosis could be seen. The height of the alveolar process adjacent to the impaired tooth is approximately 3–4 mm.



(a)



(b)

FIG. 2

Dentigerous cyst of tooth #18 in the right maxillary sinus. (a) Axial CT scan shows that the right maxillary sinus is occupied by a soft tissue attached to tooth #18 which has been displaced to the anterior part of the sinus (the round radiopaque structure in the left sinus is the apex of tooth #28). (b) Panoramic CT scans further demonstrate that the radiolucent lesion inside the sinus is attached to the cemento-enamel junction of the tooth. The crown is located inside the lesion whereas the root is outside, consistent with a dentigerous cyst.

discomfort of the right maxilla for one year. Oral examination disclosed no pathology. The third molars (#18 and 28) were missing or impacted on clinical examination.

An axial CT scan (Figure 2a) revealed that the right sinus was occupied by a soft tissue mass attached to a tooth which had been displaced to the buccal aspect of the sinus.

Panoramic CT reconstruction scans (Figure 2b) further demonstrated a large radiolucent lesion in the right maxillary antrum, causing displacement of the third molar. The crown of the tooth was located inside the radiolucent lesion whereas the root was outside, consistent with a dentigerous cyst. The cyst was enucleated and the tooth was extracted by the Caldwell-Luc approach. A histopathology report confirmed the diagnosis of a dentigerous cyst.

Case 3

This was an iatrogenic displacement of the third molar #18 into the maxillary antrum (Figure 3). A 40-year-old female, underwent extraction of tooth #18. During the extraction the tooth disappeared. A panoramic radiograph (Figure 3a) revealed a tooth-like structure in proximity to the roots of teeth #16 and #17, however the exact bucco-lingual localization was lacking. The displaced tooth may not necessarily penetrate into the antrum but may lie beneath the buccal mucoperiosteum or between the lining membrane of the antrum and the bony wall. Axial CT scan (Figure 3b) revealed that the displaced tooth was located inside the sinus. Bucco-lingual images of the right maxilla (Figure 3c) further demonstrated that the tooth was within the sinus and the crown was facing the floor. Panoramic CT reconstructed images (Figure 3d) revealed that the bony defect at the third molar socket area was not

accessible enough to recover the tooth from the sinus by a crestal incision and a Caldwell-Luc approach was chosen.

Results

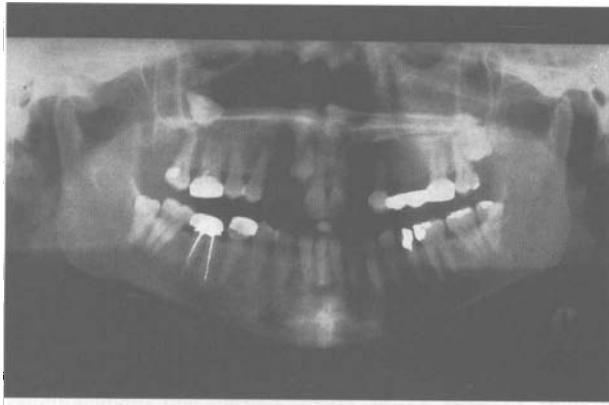
The scores given to radiographic features of teeth in maxillary antrum, interpreted from PFR as compared with CT are demonstrated in Table I. The teeth in maxillary sinus area could be identified in both the PFR and CT scans. The three-dimensional morphology of the tooth and its inclination, were fairly depicted by PFR, whereas CT provided excellent details about these features. The proximity to the bony sinus wall, surgical planning, crestal incision or Caldwell-Luc approach, prediction of prognosis or complications were poorly anticipated by PFR whereas with CT it was very accurate ($p < 0.001$).

Discussion

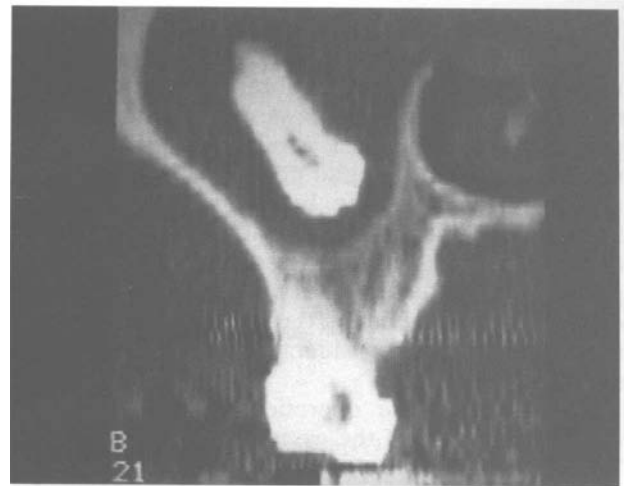
The dental CT software programme, originally designed for implant dentistry, has proven to be useful in evaluation of jaw abnormality and pathology (Bodner *et al.*, 1993; Yanagisewa *et al.*, 1993;

TABLE I
RADIOGRAPHICAL FEATURES OF TEETH IN MAXILLARY SINUS INTERPRETED FROM PLAIN FILM RADIOGRAPHY (PFR) AND COMPUTED TOMOGRAPHY (CT) SCANS

| Feature | PFR | CT | Sign test |
|--------------------------------------|------|-----------|-------------|
| Morphology | +++ | ++++ | $p < 0.01$ |
| Inclination | ++ | ++++ | $p < 0.01$ |
| Proximity to sinus wall | + | ++++ | $p < 0.001$ |
| Surgical planning | + | ++++ | $p < 0.001$ |
| Prediction of prognosis/complication | + | ++++ | $p < 0.001$ |
| Scale: | ++++ | excellent | |
| | +++ | good | |
| | ++ | fair | |
| | + | poor | |



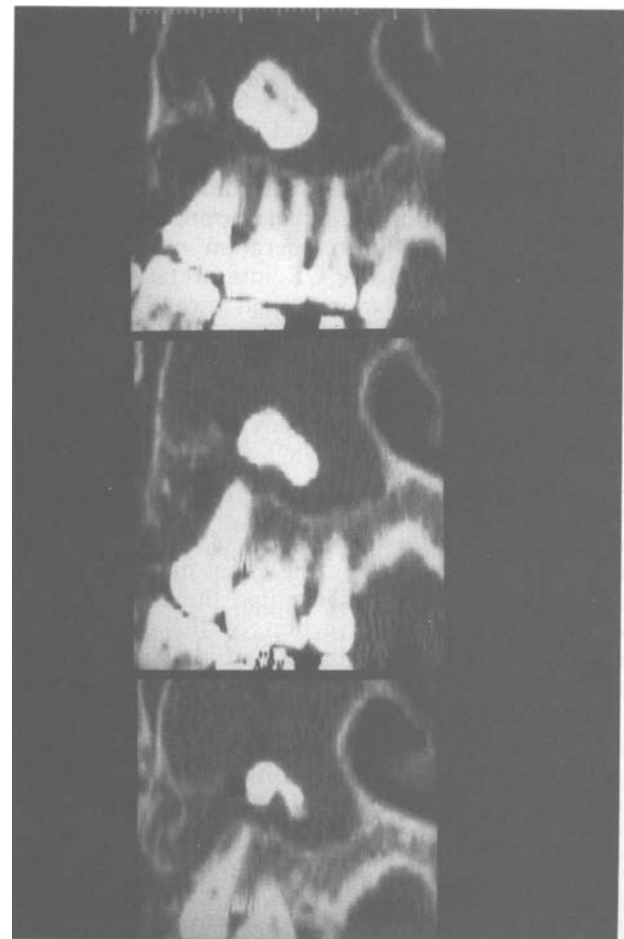
(a)



(c)



(b)



(d)

FIG. 3

Iatrogenic displacement of third molar #18 into the right maxillary antrum, during extraction. (a) Panoramic radiograph reveals a tooth-like structure in proximity of first and second molar. The bucco-lingual localization is lacking. (b) Axial CT scan demonstrates that the tooth is inside the sinus. (c) CT reconstruction of the maxilla at the bucco-lingual plane, further demonstrates that the tooth is inside the sinus and the crown is facing the floor. (d) CT reconstruction of the maxilla at the panoramic plane, demonstrates that the bony defect at the extraction socket area is small and not accessible to recover the tooth from the sinus.

Bodner *et al.*, 1994; Krennmair and Lenglinger, 1995). It permits the visualization of the maxilla and mandible in three planes: panoramic, axial and cross-sectional (bucco-lingual) views. Using such software programmes anatomical structures such as the mandibular canal, mental foramen, incisive canal and maxillary sinus can be seen in cross-section. Furthermore, the proximity of the tooth to the wall of the sinus or its ankylosis can be determined and precisely calculated. In cases where there is already a destroyed cortical bone in the sinus wall it should be taken into surgical consideration to avoid unnecessary bone loss.

The Caldwell-Luc operation (Goodman, 1976) was used in most of the cases in the present study. This approach gave excellent access to the antrum for either removing the tooth or to enucleate the cystic lesion from the sinus. The crestal incision was used in edentulous cases or where teeth or roots in the area had to be extracted and some additional bone removal up to the floor of the sinus enabled the recovery of the impacted tooth from the sinus. In some cases (such as in Figure 1) the tooth was found on the sinus floor outside the Schneiderian membrane. This approach should be used only when there is at least 3–4 mm height of alveolar bone, to prevent the complication of oro-antral communication. The decision on the surgical approach of choice, either the Caldwell-Luc operation or the crestal incision, was based on CT interpretation of the height of the alveolar crest and turned out to be accurate.

The surgical approach to cystic lesions of the jaws is either marsupialization or enucleation depending on the bony integrity of the jaw adjacent to the cyst (Horowitz and Bodner, 1989). Marsupialization of an antral cyst towards the oral cavity will consequently create an oroantral fistula, therefore enucleation is the treatment of choice. While information gained by PFR was limited in this regard, CT clearly demonstrated the extent of the cyst, the sites of destruction of the bony walls, allowing accurate diagnosis and tissue-preserving surgical management.

Similar to our present results, CT was also found superior to PFR in diagnosis of a variety of pathological or trauma conditions of the maxillofacial skeleton (Close *et al.*, 1986; Bodner *et al.*, 1993; Bodner *et al.*, 1995; Bodner and Fliss, 1995; Krennmair and Lenglinger, 1995; Epstein *et al.*, 1996). According to our experience in a series of 12 cases, it can be said that CT scan provided additional information over and above that obtained by PFR. This information was important and relevant for the management of the patients.

Conclusion

CT, and preferably with a dental CT software programme, is highly valuable for the imaging and management of teeth in the maxillary sinus.

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