Australian Endodontic Journal
The Journal of the Australian Society of Endodontology Inc., the Australian and New Zealand Academy of Endodontists and the Asian Pacific Endodontic Confederation

Aust Endod J 2014; 40: 26–31

CASE REPORT

Maxillary sinus unilateral aplasia as an incidental finding following cone-beam computed (volumetric) tomography

Liviu Steier, DrMedDent[1]; Gabriela Steier, BA[2]; Esma J Doğramacı, BDS, MFDS RCS(Eng)[3]; and Giampiero Rossi-Fedele, DDS, MClinDent[1,4]

1 Postgraduate Dental Education Unit, Institute of Clinical Education, Warwick Medical School, University of Warwick, Coventry, UK
2 Duquesne University School of Law, Pittsburgh, Pennsylvania, USA
3 Orthodontic Department, Guy's Hospital, King's College London Dental Institute, London, UK
4 Post-Graduate Program in Dentistry, Pontifical Catholic University of Rio Grande do Sul – PUCRS, Porto Alegre, Rio Grande do Sul, Brazil

Keywords
cone-beam computed tomography, incidental finding, maxillary sinus, maxillary sinus aplasia.

Correspondence
Mr Giampiero Rossi-Fedele, 10 Station Path, Staines, Middlesex TW18 4LW, UK. Email: grossifede@yahoo.com

doi:10.1111/aej.12001

Abstract

This paper presents a case of maxillary sinus unilateral aplasia, an uncommon condition in adults, diagnosed as an incidental finding during cone-beam computed tomography (CBCT) examination for an endodontic case analysis. The patient was referred to a specialist endodontic practice for management of an upper right central incisor tooth. A CBCT scan was performed. The images of the left maxillary sinus showed a total lack of pneumatisation, prompting the diagnosis of aplasia. The patient's otolaryngologist was made aware of the findings. Clinical evaluation of volumetric images should be performed by an adequately trained dentist or radiologist so the maximum amount of information is gathered for the patient. This requires a systematic approach to ensure that no relevant information is missed and should include the paranasal sinuses and other surrounding structures as incidental findings can be observed during CBCT analysis.

Introduction

Cone-beam computed tomography (CBCT) examination is one of the possible radiographic analyses available for assessment in clinical endodontics (1). It has been suggested as an aid to contribute to the diagnosis of pathosis, dental resorption evaluation and differential diagnosis of diseases of non-endodontic origin, to assist determination of canal morphology and pre-surgical assessment before root end surgery (1). The imaging field of CBCT images used in dental medicine may occasionally be considered to include some extension to the area of the maxillary sinus and the nose (2). Radiographic examination of different parts of the antra occurs with routine investigations used in dentistry including periapical and dental panoramic tomography (3). Evaluation of the maxillary sinus in dentistry can be required for implant site assessment (2), endodontic surgery planning (1) and in the diagnosis of maxillary inflammation of dental origin and oroantral fistulae (2).

Incidental findings have been defined as 'findings that appear unrelated to the scan's original purpose' (4); those involving CBCT frequently involve sinus pathologies (2). Their incidence in CBCT tests for dental assessment procedures, including implant, orthodontic, endodontic and temporomandibular joint (TMJ) disorder patients has been found to be 24.6% (4). For endodontic patients in particular, the occurrence of findings without direct significance to the original treatment has been found to be 33% and mainly involving the airways (4). A 56.3% prevalence of pathology was detected in one or both sinuses using CBCT scans, which had been prescribed mostly for implant assessment and trauma or secondarily for extraction, orthodontic treatment planning, neoplasia or sinus analysis (2).

The maxillary antrum or sinus is normally the largest of the paranasal sinuses (5) with a volume of approximately 6–8 cm^3 (6) although their size varies depending on the individual and their age (7). It occupies most of the body of the maxilla being limited by the following structures:

the mesial wall forms part of the lateral part of the nose and the apex extends into the zygomatic process of the maxilla. The roof is part of the floor of the orbit; the floor is formed by the alveolar process and part of maxillary palatine process and is related to the upper posterior teeth root apices. Its anterior and posterior walls are the facial wall and infratemporal surface of the maxilla respectively. This approximately pyramidal air-filled cavity is lined by ciliated columnar respiratory epithelium (5).

The normal appearance of the maxillary sinus is a radiolucent cavity with well-defined, dense and corticated radio-opaque bony margins or walls (3). The main radiological signs of disease include opacity and/or presence of a foreign body within the antrum and alteration of the integrity of the antral walls and/or outline (3).

Maxillary sinus aplasia is a failure of sinus development (8,9) and it presents as only a shallow cleft in the lateral nasal wall (8), an extremely rare condition (9). The precise aetiology is uncertain though it has been suggested to be related to abnormalities in intrauterine development or reduced nasal ventilation due to sinusitis in the first year of life (10). Absent antra can be related to abnormal maxillary growth (8), with consequent aesthetic defects such as flattening in the malar region (11) and are often associated with systemic or skeletal diseases (6).

The aim of this paper is to present a case report highlighting maxillary sinus absence encountered as an incidental finding during radiographic examination using CBCT prescribed for endodontic case analysis purposes.

Figure 1 Periapical radiograph of upper right central and lateral incisor teeth showing the presence of root canal fillings, resected root ends and a periapical radiolucency associated to the central incisor. There is evidence of a radiopaque foreign body in the periapical tissues, related to the upper right lateral incisor tooth; a likely attempted root end filling.

Case report

A 58-year-old Caucasian female with no significant medical background was referred to an endodontic practice for management of her maxillary right central incisor (tooth 11). The patient's chief complaint was a 2-year history of recurrent swelling and purulent discharge associated with this tooth and a concurrent history of recurrent and severe otitis media; the latter was under review by her otolaryngologist.

During consultation, she recalled having suffered trauma to the anterior maxilla (age 11). The tooth was subsequently diagnosed as having sustained a coronal fracture and was endodontically treated and restored with a cast restoration. Recurrent acute episodes over the 10 years after the trauma led to the tooth being retreated in orthograde and retrograde fashions.

Extra-oral clinical examination demonstrated slight flattening in the left malar region thus resulting in minor facial asymmetry in profile view in the anteroposterior plane. Transversally, there was no apparent facial asymmetry. A preoperative periapical radiograph of the upper right anterior teeth shows that the incisors have root canal fillings and resected roots; an apical radiolucency is associated to the central incisor (Fig. 1).

As part of the examination and in light of the previous endodontic surgery, it was deemed important to assess the extent and topography of the periapical lesion as part of pre-surgical case planning. Furthermore, investigation of bone volume, quality and topography was considered necessary to evaluate if replacement of the tooth with an implant was a viable alternative. The patient was referred to a local radiography centre for a CBCT scan; an i-CAT scanner (Imaging Sciences International, Hatfield, PA, USA) was used. CBCT scans (panoramic reconstruction and axial slices) showed a total lack of pneumatisation of the left maxillary antrum (Figs 2–7) leading to the diagnosis of maxillary sinus aplasia. The patient's otolaryngologist was made aware of the findings.

Discussion

The decision to order a volumetric examination should be based on the patient's history and clinical examination. It

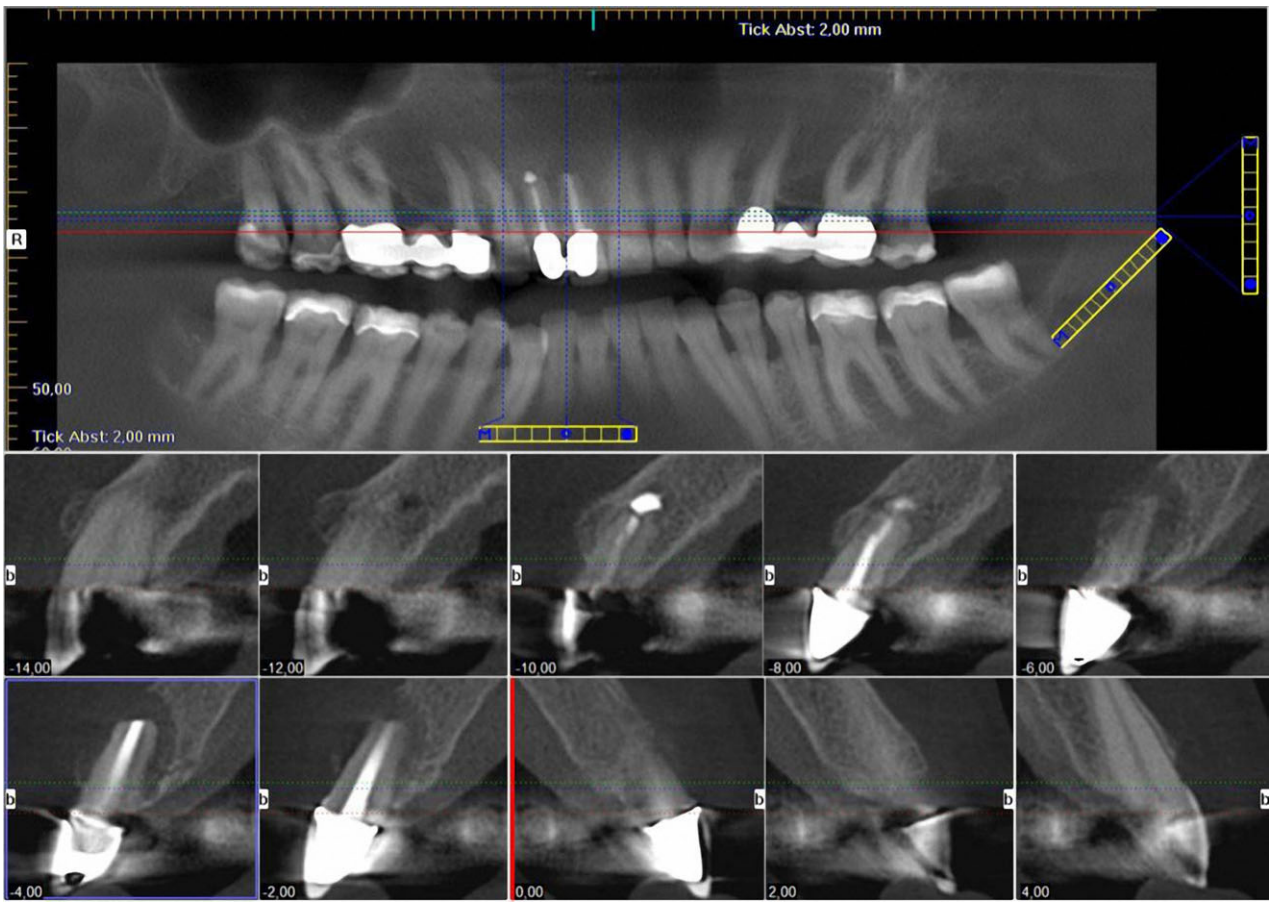

Figure 2 Panoramic view and sagittal sections area teeth 11 and 12.

Figure 3 Anatomage reconstruction.

should be used only when the information required cannot be observed with a two-dimensional imaging modality (12). CBCT examination is efficient in detecting incidental findings in the maxillofacial area (4) with the maxillary sinus being one of the most frequent locations (2). CBCT scans have been shown to assist a diagnosis of inflammatory changes in the antra as well as their potential causes (7). The vast majority of incidental findings observed in CBCT scans that are taken for dental and TMJ diagnostic purposes are related to the airways. These findings include sinusitis, thickened mucosae, antral polyps, retention cysts and septum deviations (4).

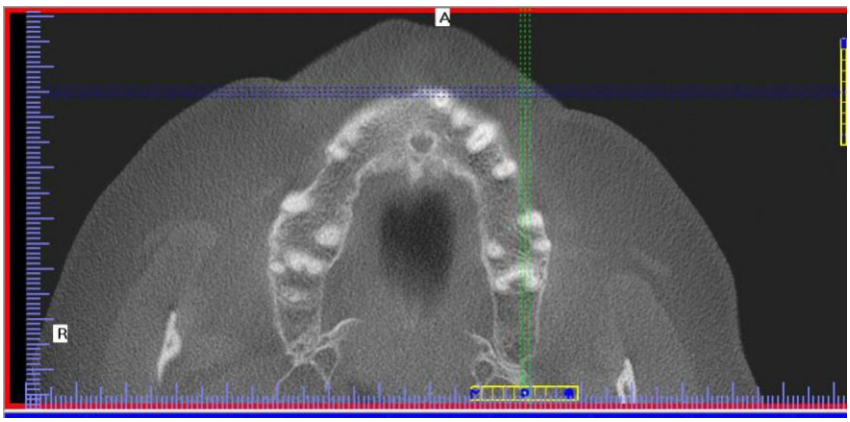

Figure 4 Axial view at root level.

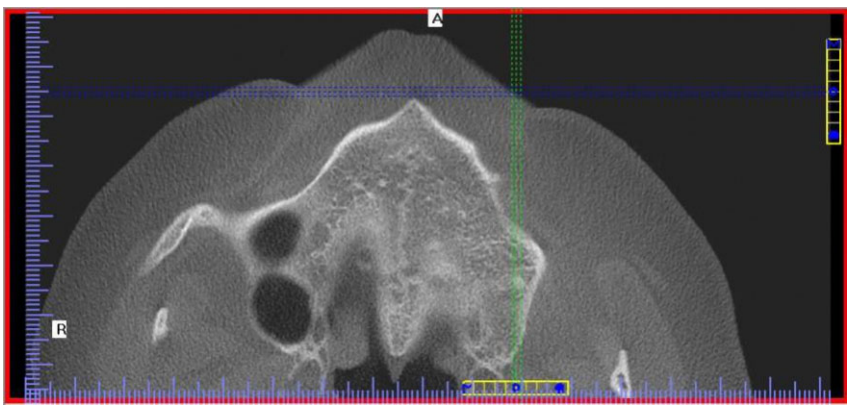

Figure 5 Axial view at sinus base level.

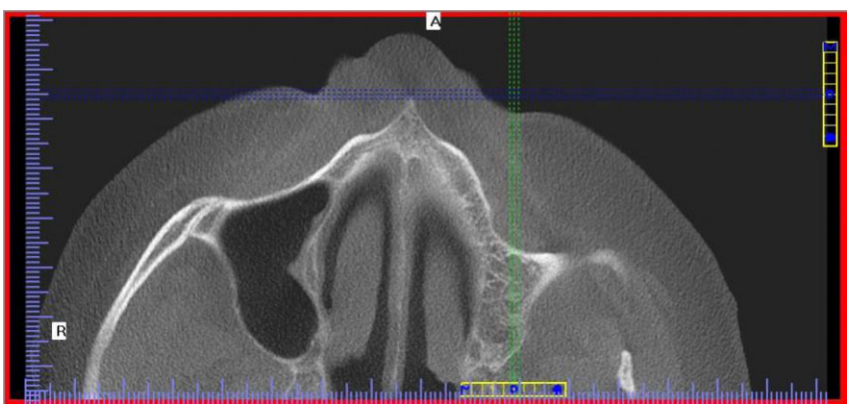

Figure 6 Axial view at mid-sinus level.

A different investigation looking into the prevalence of pathologic findings in CBCT found that mucosal thickening was the most frequently detected pathology (2).

The relationship between symptoms related to the airways and incidental findings is weak as only 22% of the patients had a relevant clinical history in a previous investigation looking into this aspect (4). Conversely,

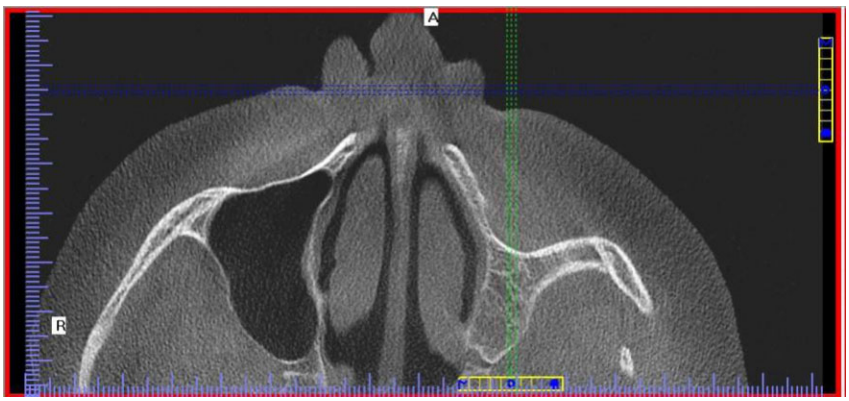

Figure 7 Axial view at mid-sinus level superior.

another study found that clinical signs of sinusitis could be confirmed by CBCT images in 100% of patients (2).

Standard computed tomography (CT) and magnetic resonance imaging are normally used by otolaryngologists to assess paranasal sinuses as they provide outstanding soft tissue discrimination due to the higher contrast when compared with CBCT. The visualisation of the bone and sinus is similar in both methodologies; however, CBCT uses a lower radiographic dosage (13).

Paranasal sinuses may have a great diversity of anomalies (14) with the underdevelopment of the paranasal sinuses being an unusual phenomenon involving most frequently the frontal sinus and less often the other sinuses; the agenesis of the maxillary sinus is a very rare anomaly (11). Literature on maxillary sinus aplasia is presented mainly by case reports using CT evaluation (9,11,14). To the best of our knowledge, no case report has previously been reported in the literature involving the use of CBCT. A retrospective CT study of 1526 radiographs of the maxillary sinus from patients with suspected paranasal sinus variations found two cases of maxillary sinus absence; one bilateral, the other unilateral (6). It is worth mentioning that studies carried out on selected groups should not be assumed to reflect the actual incidence of a disease (15).

An opaque antrum detected on radiographs or on cross-sectional imaging leads to an extensive radiological differential diagnosis; developmental abnormalities of the antra can be misdiagnosed as sinusitis or neoplasm (8,9,11). Planar films are considered unreliable to differentiate these entities and tomographic examinations are required to contribute to a more accurate diagnosis. It is necessary to draw attention to the fact that is often difficult to differentiate between severe hypoplasia and aplasia (16) though CBCT and CT imaging can prove useful for this purpose. In our case report, the scan is not extended to show the area where the left antrum would have been on its most superior aspect; therefore, definitive diagnosis of aplasia or hypoplasia cannot be confirmed. It is worth noting that there is some degree of overlap in terminology as an authoritative classification of maxillary hypoplasia describes its type III as 'a profoundly hypoplastic, cleft-like sinus' (17), which is similar to the definition of aplasia used by Güven *et al.* (8).

Occasional incidental findings might be detected following CBCT examination of the oral cavity. Therefore, a thorough and systematic evaluation of the images should be carried out by an adequately trained dentist or radiologist, considering that the clinician requesting the images is responsible for interpreting the entire image volume and can be held liable for missed diagnoses (12).

This is of particular relevance in case a CBCT scan with a larger field of view (FOV) than required or ideal is obtained, to ensure that nothing is overlooked in the areas of non-dental interest and the patient gains the maximum advantage from the scan. This report shows one of these incidental findings. Referral to an otolaryngologist or other relevant clinicians for further assessment of any findings should follow. Sinus aplasia is a developmental variant and requires no treatment; therefore, communication of the findings was considered sufficient in this case. Flattening of the malar region is usually indicative of an underlying maxillary deficiency in the midface region. The radiographic analysis confirmed the clinical findings; flattened appearance of the overlying soft tissues in the region of left maxillary deficiency subsequent to sinus aplasia, when compared to the contralateral side.

In this case, a medium FOV size scan was used; however a small volume FOV, with high resolution, would have better suited the scan's original purpose. This FOV was used because the local imaging centre only offered this image size since at the time, only a 'classic' i-CAT scanner model was available there. Subsequently a

modification to reduce the FOV via a combination of collimation within the machine and a patient positioning device has been offered by the manufacturer of this scanner, in order to reduce the patient dosage. As ionising radiographic exposure entails risks to the patient, clinicians have a duty to weigh the potential diagnostic benefits against the detrimental effects associated with the exposure. That is to say, it is imperative that radiographic imaging is requested and undertaken so to maximise their diagnostic value while keeping the radiation doses as low as reasonably achievable (12). CBCT examinations should use the smallest volume size compatible with the clinical situation in order to provide the minimal possible radiation dose to the patient (12) as the dose received is strongly correlated to FOV size (12,18,19).

In summary, this report presents a case of unilateral maxillary sinus aplasia, an uncommon condition in adults, diagnosed as an incidental finding during CBCT examination as part of an endodontic case analysis. This highlights the importance of the fact that scans should be interpreted by adequately trained and experienced radiologists or dentists, in order to provide the maximum benefit to the patient.

References

1. Cotton TP, Geisler TM, Holden DT, Schwartz SA, Schindler WG. Endodontic applications of cone-beam volumetric tomography. J Endod 2007; 33: 1121–32.
2. Ritter L, Lutz J, Neugebauer J *et al*. Prevalence of pathologic findings in the maxillary sinus in cone beam computerized tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011; 111: 634–40.
3. Whaites E. Essentials of dental radiography and radiology. 3rd ed. Philadelphia, PA: Churchill Livingstone; 2002.
4. Cha JY, Mah J, Sinclair P. Incidental findings in the maxillofacial area with 3-dimensional cone-beam imaging. Am J Orthod Dentofacial Orthop 2007; 132: 7–14.
5. Berkovitz BKB, Holland GR, Moxham BJ. Oral anatomy, histology and embryology. 3rd ed. Philadelphia, PA: Mosby; 2002.
6. Aydinlioğlu A, Erdem S. Maxillary and sphenoid aplasia in Turkish individuals: a retrospective review using computed tomography. Clin Anat 2004; 17: 618–22.
7. Maillet M, Bowles WR, McClanahan SL, John MT, Ahmad M. Cone-beam computed tomography evaluation of maxillary sinusitis. J Endod 2011; 37: 753–7.
8. Güven DG, Yılmaz S, Ulus S, Subaşı B. Combined aplasia of sphenoid, frontal, and maxillary sinuses accompanied by ethmoid sinus hypoplasia. J Craniofac Surg 2010; 21: 1431–3.
9. Tasar M, Cankal F, Bozlar U, Hidir Y, Saglam M, Ors F. Bilateral maxillary sinus hypoplasia and aplasia: radiological and clinical findings. Dentomaxillofac Radiol 2007; 36: 412–5.
10. Whyte A, Chapeikin G. Opaque maxillary antrum: a pictorial review. Australas Radiol 2005; 49: 203–13.
11. Chrcanovic BR, Freire-Maia B. Maxillary sinus aplasia. Oral Maxillofac Surg 2010; 14: 187–91.
12. European Commission. 2012) *Radiation Protection: Cone Beam CT for Dental and Maxillofacial Radiology*. Evidence based guidelines [PDF on internet]. Luxembourg: Luxembourg. [Updated March 2012, cited 27 May 2012.] Available from URL: http://ec.europa.eu/energy/nuclear/radiation_protection/doc/publication/172.pdf
13. Chau ACM, Fung K. Comparison of radiation dose for implant imaging using conventional spiral tomography, computed tomography and cone-beam computed tomography. Oral Surg Oral Med Oral Path Oral Radiol Endod 2009; 107: 559–65.
14. Haktanir A, Acar M, Yucel A, Aycicek A, Bedirmenci B, Albayrak R. Combined sphenoid and frontal sinus aplasia accompanied by bilateral maxillary and ethmoid sinus hypoplasia. Br J Radiol 2005; 78: 1053–6.
15. Selcuk A, Ozcan KM, Akdogan O, Bilal N, Dere H. Variations of maxillary sinus and accompanying anatomical and pathological structures. J Craniofac Surg 2008; 19: 159–64.
16. Baykara M, Erdoğan N, Óztürk M, Erkan M. Maxillary sinus aplasia. Turk J Med Sci 2002; 32: 273–5.
17. Bolger WE, Woodruff WW, Morehead J, Parsons DS. Maxillary sinus hypoplasia: classification and description of associated uncinate process hypoplasia. Otolaryngol Head Neck Surg 1990; 103: 749–65.
18. Ludlow JB, Ivanovic M. Comparative dosimetry of dental CBCT devices and 64-slice CT for oral and maxillofacial radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008; 106: 106–14.
19. Pauwels R, Beinsberger J, Collaert B *et al*. Effective dose range for dental cone beam computed tomography scanners. Eur J Radiol 2012; 81: 267–71.