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# Are Changes in Specific Landmark Anatomy on a Panoramic Image Suggestive of Maxillary Sinus Disease?

**Abstract:** Dental panoramic radiography is a commonly employed investigation in dentistry, however, its use in the primary indication of maxillary sinus disease is often underestimated. Being able to identify anomalies or abnormalities involving the maxillary sinus on radiographs will facilitate early intervention and appropriate referral to the relevant specialties.

**CPD/Clinical Relevance:** Dentists should have a good understanding of radiographic anatomy of the maxillary sinus. Recognizing radiographic changes allows appropriate referral and improved patient care.

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Due to their anatomical location, the maxillary sinuses should be assessed when establishing a diagnosis for orofacial pain and any diseases relating to upper teeth.<sup>1</sup> Dentists should be able to interpret conventional panoramic radiography, including having good knowledge of normal anatomy and its variants. For general dental practitioners (GDPs), panoramic radiography is widely accessible and is a common radiographic technique used in assessing pathosis, particularly of larger lesions not fully imaged by intra-oral radiography. Dentists are thought to prescribe

2.7 million panoramic radiographs per year in the UK, and they will often be the first to identify coincidental findings of maxillary sinus disease.<sup>2</sup>

Being able to distinguish between dental and maxillary sinus symptoms enables the dentist to determine when dental treatment is appropriate and when referral to a different specialty is more apt. Similarly, being able to interpret dental radiographs systematically will enable the dentist to identify both dental and sinus pathology competently.

Extensive lesions occupying the maxillary sinus can often produce surprisingly few clinical features. Therefore, panoramic radiographs can frequently be used to indicate the presence of maxillary sinus disease.<sup>3</sup>

There is a wide variety of pathological conditions that affects the maxillary sinuses (Table 1). These can be categorized into those that originate from the sinus epithelium, the adjacent paranasal sinuses, nasal cavity, dental tissues, or in the adjacent bony structures with expansion into maxillary antrum.<sup>2</sup> Specifically, extrinsic cysts of odontogenic origin will be the focus of this article. One should also

consider developmental and anatomical variations, which may present as false-positive radiographic change of disease.

## Landmarks in the maxillary sinus area on a panoramic image

Radiological assessment of the maxillary sinuses requires a thorough examination, including the degree of aeration and alteration of the bony outlines of the maxillary sinuses. There are three key anatomical radio-opaque lines visible on a panoramic radiograph, which should be carefully traced when detecting disease associated with the maxillary sinus. Two further lines should also be acknowledged, that is those of the hard palate and the floor of the maxillary antrum. However, these would only be distorted in extensive lesions which perforate these walls and, therefore, they would be clinically palpable.

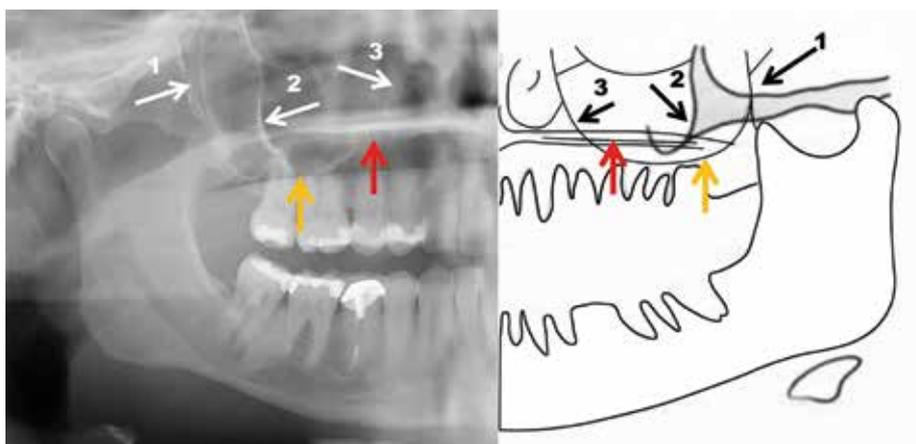
The three lines are:

1. The anteromedial wall of the maxillary antrum;

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Pathological and developmental conditions affecting the maxillary sinuses which present with radiographic changes				
Examples				
Inflammatory	<i>Acute and chronic sinusitis</i>			
Trauma	<i>Haematoma</i>			
Neoplasms	<i>Adenocarcinoma</i>			
	<i>Ameloblastoma</i>			
Calcification	<i>Anthrolith</i>			
Developmental conditions	<i>Fibrous dysplasia</i>			
Other bone abnormalities	<i>Paget's disease of bone</i>			
Cysts	Intrinsic	<i>Mucous (or mucosal) retention cyst</i>		
	Extrinsic	Odontogenic	Developmental	<i>Odontogenic Keratocyst Dentigerous cyst</i>
			Inflammatory	<i>Radicular cyst</i>
		Non-odontogenic	<i>Nasopalatine cyst</i>	

**Table 1.** Examples of pathological and developmental conditions that affect the maxillary sinuses. The list of examples is by no means exhaustive but the effects of odontogenic cysts are demonstrated in this article.



**Figure 1.** A standard panoramic radiograph with the key hard tissue shadows associated with the right maxillary sinus outlined. A line diagram represents these landmarks more clearly. 1) Pterygomaxillary fissure; 2) zygomatic buttress; 3) anteromedial wall of the maxillary antrum. The hard palate (red arrow) and floor of the maxillary antrum (yellow arrow) should also be considered.

- 2. The pterygomaxillary fissure;
- 3. The zygomatic buttress.

These anatomical hard tissue shadows can be illustrated on a standard panoramic radiograph (Figure 1).

The pterygomaxillary fissure is medial to the temporal fossa and is bounded by the pterygoid process of the sphenoid bone

(superiorly), pterygoid plate of the sphenoid bone (inferiorly) and the posterior wall of the maxillary sinus (anteriorly). This landmark appears as a teardrop-shaped shadow (Figure 2).

The zygomatic processes of the maxilla are thick buttresses of bone, which extend laterally from the maxilla and appear as J-shaped or hockey stick shadows superimposed

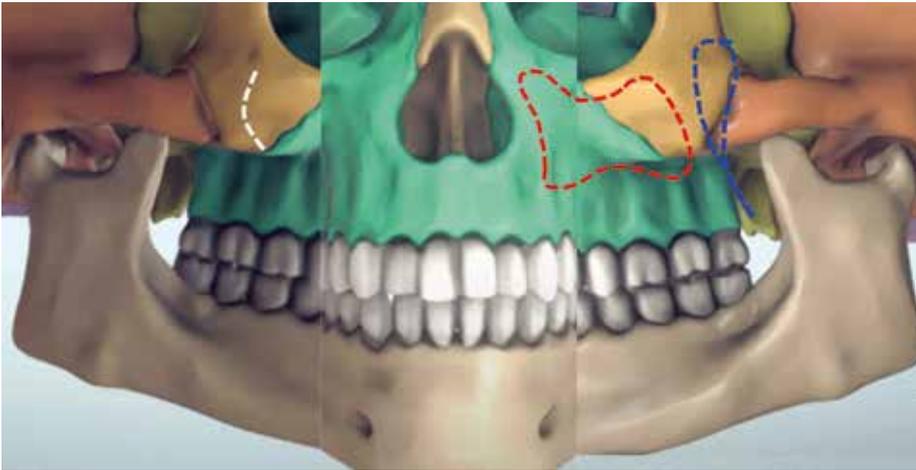
over the maxillary sinuses (Figure 2).

The anteromedial wall of the maxillary antrum is composed of the lateral wall of the nasal cavity and the facial surface of the superior maxilla (Figure 2).

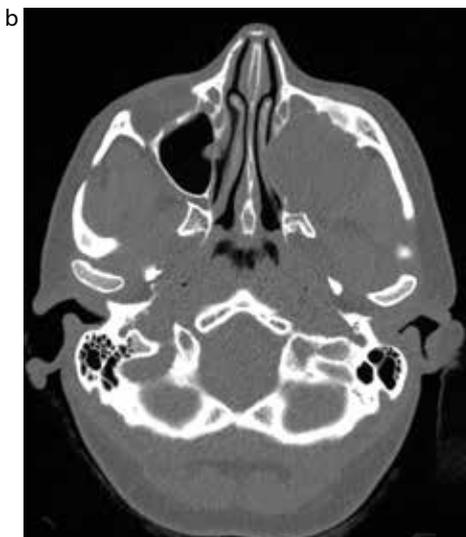
### Interpreting maxillary sinus disease on two-dimensional (2-D) images versus visualizing maxillary sinus disease on three-dimensional (3-D) images

The absence of any of the real hard tissue shadows shown in Figure 1 may indicate the presence and extent of sinus disease (Figures 3–8). This article presents a series of clinical cases in which a dento-alveolar lesion was suspected on a panoramic radiograph and a referral to an oral surgery specialist was made for further investigation.

By considering these changes on panoramic radiography (Figure 1), along with a clinical history and examination, further radiographic investigation, such as computed tomography (CT) or cone-beam computed tomography (CBCT), was performed if it was deemed appropriate. In the majority of cases, 2-D imaging does not allow visualization of



**Figure 2.** These three lines can be represented on the lateral and frontal views of the skull. The frontal process of the maxilla (green surface) and lateral nasal wall compose the anteromedial wall of the maxillary sinus (red line). The zygomatic buttress (white line) is located in the region of the zygomatic process of the maxilla. The relative position of the pterygomaxillary fissure is marked as the blue line.



**Figure 3. (a, b)** A 41-year-old female presented with a one-year history of recurrent left-sided facial pain. A CT scan revealed a large cyst associated with an ectopic left maxillary third molar. The cyst occupied almost the entire maxillary sinus and extended into the left lateral nasal fossa. Note the loss of the hard tissue shadows of the lateral nasal wall, zygomatic buttress and pterygomaxillary fissure on the panoramic radiograph. Histopathology results following enucleation confirm the lesion as a dentigerous cyst.

the size of the disease process, its effects on surrounding structures and its composition. Therefore, 3-D imaging is often required to complement the primary investigations.<sup>4</sup>

### Discussion

Although there are clear radiographic changes visible on panoramic radiography, there is no indication as to the extent of the disease. Despite the obvious advantages of low radiation dose and a large visualization of the facial bones, their use is limited for a number of reasons.<sup>4</sup> Panoramic radiographs are unreliable in comprehensively confirming the absence or presence of disease owing to the superimposition of soft tissue, air and artefactual shadows which can overlie the required hard tissue structures. Furthermore, panoramic images are prone to distortion, particularly due to positioning errors.<sup>1</sup> In addition, if a panoramic radiograph appears normal, then it does not necessarily indicate that there is no disease present (false-negative findings). However, the clinician should be able to appreciate that both clinical symptoms and radiographic changes may signify that further investigations are required, usually in the form of 3-D radiographic imaging.

Appropriate referral for advanced imaging in a secondary or tertiary care setting should comply with Ionizing Radiation (Medical Exposure) Regulations (IR(ME)R) 2000.<sup>5</sup> If an abnormality is identified on a panoramic radiograph, either by a GDP or another specialty, then a referral to an appropriate specialist should be made. At this stage, the specialist may consider advanced imaging, such as a CBCT or conventional CT scan, to assist with patient management or treatment.

There have been various studies that have compared the use of 2-D and 3-D radiographic imaging in evaluating the maxillary sinuses. Tadinada *et al* showed that, although both panoramic radiographs and CBCT showed high sensitivity for identifying maxillary sinus pathology, CBCT showed considerably higher specificity.<sup>6</sup> In addition, their findings indicate that there is merely a 1 in 2 success rate in the detection of pathology by panoramic radiographs. Similarly, Vallo *et al* highlighted a statistically significant difference in the identification of apical periodontitis in the posterior maxilla between panoramic radiography and CBCT, with the latter being more favourable.<sup>7</sup>



**Figure 4. (a, b)** A 32-year-old female presented with recurrent intra-oral and nasal pus drainage. The upper left third molar was extracted three years earlier and the panoramic radiograph highlights the loss of the hard tissue shadow of the left pterygomaxillary fissure. The axial section of the CT scan shows a well-defined corticated ovoid lesion containing irregular soft tissue. She was diagnosed with a 4 cm thick-walled, odontogenic keratocyst occupying the left maxillary sinus.



**Figure 5. (a–c)** A 28-year-old male presented with an asymptomatic, slow-growing, left-sided, extra-oral swelling of the maxilla. The CT scan indicated that there is a large and expansive presumed cystic bony mass in the anterolateral aspect of the maxilla. The cystic mass encroaches the anterior half of the left maxillary antrum and measures 5.5 x 3.9 x 4 cm. The shadow of the left anteromedial wall on the panoramic radiograph is completely lost. The 3-D reconstruction illustrated the extent of the lesion perforating through the anterolateral wall of the maxilla, hence the ability to palpate the lesion on presentation. Histopathological findings indicated that this was likely to be a large residual cyst.

A recent study by Dau *et al* examined the diagnostic accuracy of panoramic radiography versus CBCT in symptomatic maxillary sinus pathologies.<sup>8</sup> It was concluded

that panoramic radiography alone was insufficient in evaluating sinus disease, however, it still remains a useful diagnostic tool, depending on the clinician's training and

expertise. Similar findings were reported by Malina-Altzinger *et al*, with advanced imaging providing a more consistent and precise evaluation of specific maxillary sinus conditions.<sup>9</sup>



**Figure 6. (a, b)** A 49-year-old male presented with a left-sided nasal obstruction and a foul taste in his mouth. The left anteromedial wall appeared partially absent on the panoramic radiograph. A CT scan showed expansion of the anterior and lateral wall of the left maxilla. The upper left third molar is embedded in the posterior wall of the maxillary sinus. A dentigerous cyst associated with the unerupted upper left third molar completely occupies the left maxillary sinus.



**Figure 7. (a, b)** A 68-year-old female directly referred from a GDP for a left-sided, slow-growing swelling of the face. On examination, there was an obvious swelling on the left maxillary prominence and zygomatic area. The panoramic radiograph confirms its cystic nature with the loss of the left zygomatic buttress and periodontal ligament space of the upper left second and third molars. The CT scan illustrated a homogeneous cystic lesion that expands superiorly in the left maxillary antrum and protrudes medially into the middle and inferior turbinates, causing partial blockage of the nasal air spaces. Enucleation of the entire cyst and histopathological findings confirmed the lesion as an odontogenic keratocyst.



**Figure 8. (a, b)** A 26-year-old male presented to our ear, nose and throat (ENT) colleagues complaining of a left-sided nasal obstruction and epiphora. He had a 4-month history of an increasing, non-painful bony swelling in the left maxilla, specifically in the region of the upper left first premolar, second premolar and first molar. The left anteromedial wall of the maxillary antrum is absent on the panoramic radiograph. One should note the large periapical radiolucent lesions associated with the roots of the upper right and left first molars. The CT scan identified a large expansile 3 x 4.4 x 4 cm bony cystic lesion occupying the entire left maxillary sinus and completely blocking its drainage. The size of this lesion has caused obliteration of the left nasal cavity and deviation of the nasal septum. There is a smaller bony cystic lesion in the right maxillary antrum. Enucleation of the bilateral cysts was performed and confirmed as radicular cysts associated with the upper right and left first molars.

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## Conclusion

Whilst caution is advised for the use of panoramic radiography in eliminating the presence of disease, it can be a reliable indicator of extension of the disease process through the walls of the maxillary sinus. It should be appreciated that the floor and medial and posterior walls of the antrum are well shown on panoramic radiographs. Consequently, it is a useful adjunct for indicating large disease processes that have perforated the sinus walls. This is critical as lesions will often fill the sinus space before patient symptoms are displayed. The use of such 2-D radiographic imaging should not be underestimated, but it is clear that it should be supplemented with far superior imaging techniques prior to any intervention to aid in diagnosis and surgical planning.

This case series has outlined the value in detecting a distortion or absence of three anatomical landmarks on panoramic radiographs. This initial incidental finding has led to a change of approach at a consultant and junior level. Clinicians would benefit by having an increased awareness of certain radiographic features, which indicate the need for further imaging, and the aim is for this level of understanding to be translated to the primary care setting.

It is the authors' recommendation that clinicians should identify such changes in panoramic radiographs and correlate this information with the clinical findings to make an appropriate referral to a specialist in a secondary or tertiary care setting. At this stage, based on the history and clinical examination, the need for more reliable and advanced imaging, such as CT or CBCT, should be considered.

## Conflicts of interest:

None.

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