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Pathologic conditions of the maxillary sinus

By Dr. Allan G. Farman in collaboration with Dr. C.J. Nortjé

Radiography of the maxillary sinuses is often undertaken using computed tomography, magnetic resonance imaging, or the occipito-mental plain x-ray film projection. However the panoramic radiograph has been found superior to the latter for detection of "cyst-like densities." (1). The occipito-mental technique, first described by Waters and Waldron, clearly demonstrates the superior, inferior and lateral margins of the maxillary sinuses while reflecting the shadows of the petrous temporal bones downwards below the inferior margin of the sinuses (2). It also demonstrates well any soft tissue or fluid contents of the sinus (1); however, this method does not display the cortices of the anterior and posterior wall.

While CT, MRI and the Waters' projection are well suited to demonstrate the maxillary sinuses, these methods are only employed if there are signs and symptoms of disease, by which time the prognosis for patients having such insidious disease as squamous-cell carcinoma can be poor (3). Extensive lesions occupying the maxillary sinus can produce surprisingly few clinical features (4). For this reason, the panoramic radiograph can be the primary indication of maxillary sinus disease. While panoramic radiography can be used to detect maxillary sinus disease, it cannot be used to entirely exclude sinus pathology. Only the portions of the sinus that are within the

image layer will be demonstrated. As the panoramic image layer most closely reflects the dental arch, sinus disease occasionally arises within the sinuses outside the image layer.

Diseases of the maxillary sinus are comparatively frequent, even in apparently young individuals - with rates in excess of one in five individuals examined using the Waters' projection (mucosal thickening 12.3%; cysts or polyps 7.2%; opacified sinus 3.3%) (5). For this reason, it is incumbent upon the dental practitioner to understand the panoramic radiological features of disease and normal variations within the paranasal sinuses. Certainly the patient should not be referred to an ear, nose and throat specialist for every instance of antral mucosal thickening or mucous retention cyst (Fig. 1 & 2), nor should the dentist ignore features that possibly reflect an early malignancy. The reputation of a practitioner is greatly enhanced given appropriate referrals that can make the difference between life and death. Failure to diagnose, on the other hand, can result in notoriety.

Nortjé et al (3) were among the first to comprehensively study the appearance on panoramic dental radiographs of pathological conditions affecting the maxillary sinuses, comparing inflammatory conditions of dental origin, iatrogenic disease/foreign bodies, non-odontogenic inflammatory conditions, cysts, benign neoplasms, malignant neoplasms and dysplasias affecting the maxilla.

“The early detection of insidious maxillary sinus disease can be very important for the patient’s prognosis, especially in the case of malignant neoplasia.”

Chronic abscesses resulted in a loss of the outline of the lower border of the sinus where it abutted the associated tooth, and a related thickening of the sinus mucosa was occasionally evident. Radicular cysts (generally associated with the root apex of a carious or fractured tooth) and residual cysts caused an upward displacement of the floor of the sinus, but the cortical outline remained intact. Extensive dental cysts extended into the sinus away from the original epicenter (Fig. 3). Even a very large radicular cyst arising in the maxilla resulted in surprisingly little in the way of clinically noticeable jaw expansion. Dentigerous cysts had a similar effect on the floor of the maxillary sinus to that observed for radicular cysts, however, the dentigerous cyst enveloped the crown of an unerupted tooth. As the tooth was displaced there was the appearance of a tooth suspended within the sinus.

Odontogenic keratocysts are homogeneous radiolucencies that might be unilocular, crenulated or multilocular in outline, and occasionally they envelope unerupted teeth (Fig. 4). These also tend to displace the sinus floor and to extend into the sinus while producing little in the way of jaw expansion. Benign tumors in general displaced the sinus floor and expanded into the maxillary sinus rather than outwards (Fig. 5). Trabeculation within multilocular tumors such as the myxoma and the ameloblastoma frequently obscured the maxillary sinus outline. In comparison with benign neoplasms, malignant tumors affecting the portion of the sinus screened by the plane of the panoramic radiograph resulted in irregular erosion of bone.



Fig. 1. Mucous retention “cyst”: detail from panoramic radiograph shows domed soft tissue density in left maxillary sinus (arrow).



Fig. 2. Mucous retention cyst of maxillary sinus (arrow) shown using the occipito-mental projection (Waters’ projection). This projection can be made using the cephal attachment available for use with panoramic systems.

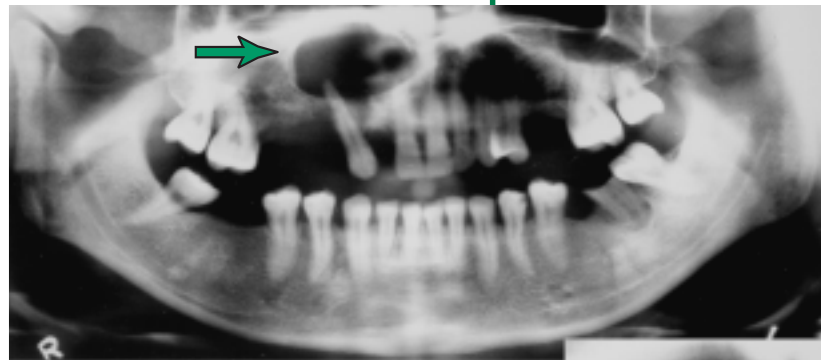


Fig. 3. Radicular cyst on carious right maxillary lateral incisor. The lesion is a well-delineated unilocular homogeneous radiolucency. It has grown so large that it has caused a displacement of the ipsilateral anterior wall and floor of the maxillary sinus.



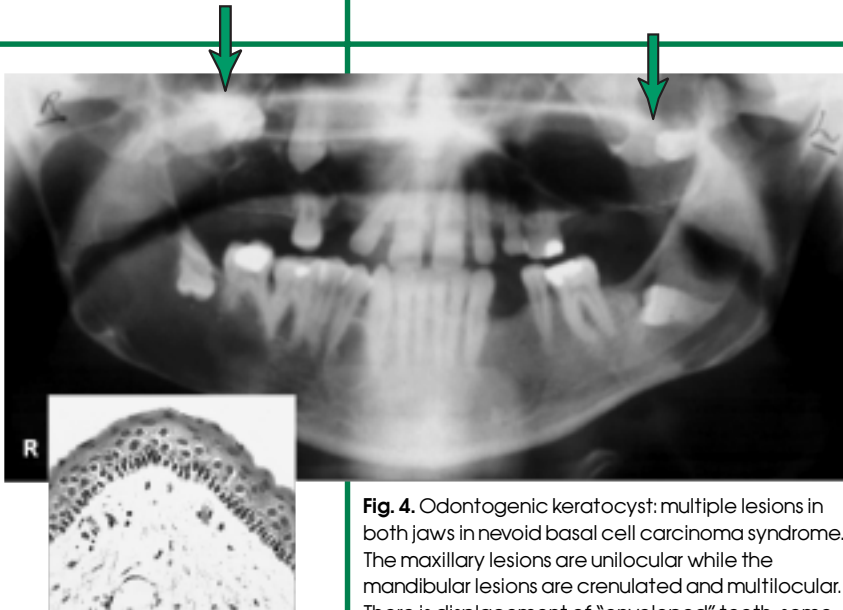


Fig. 4. Odontogenic keratocyst: multiple lesions in both jaws in nevoid basal cell carcinoma syndrome. The maxillary lesions are unilocular while the mandibular lesions are crenulated and multilocular. There is displacement of “enveloped” teeth, some of which apparently “float” in the maxillary sinuses (e.g. arrows).

Fig. 5. Benign neoplasm, adenomatoid odontogenic tumor: unilocular lesion in the left maxilla subjacent to the canine tooth (cropped panoramic, occlusal and specimen radiographs). Note displacement of maxillary sinus floor (arrow).

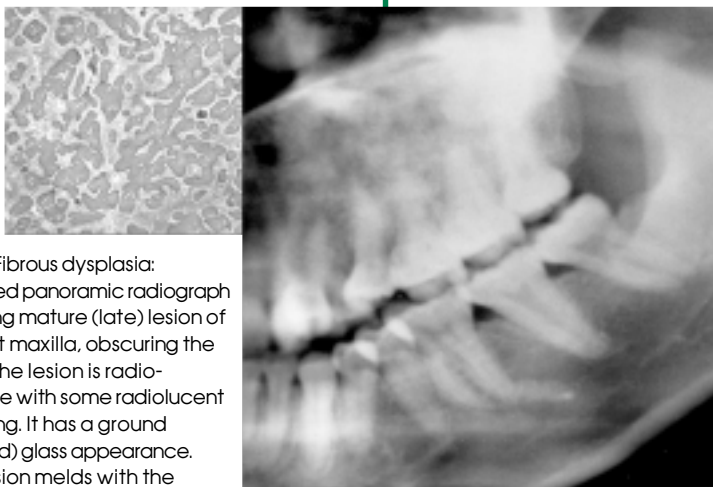
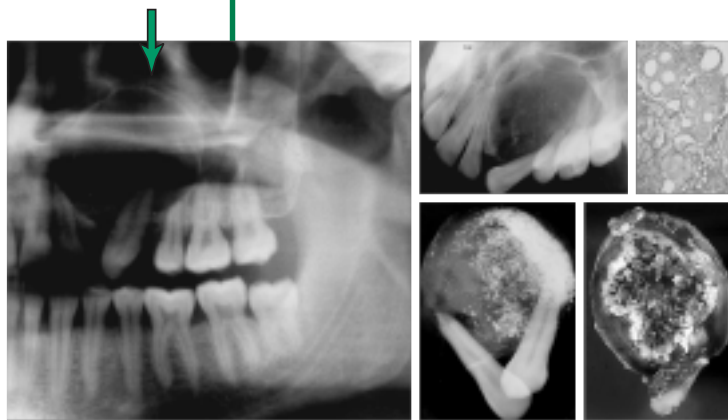


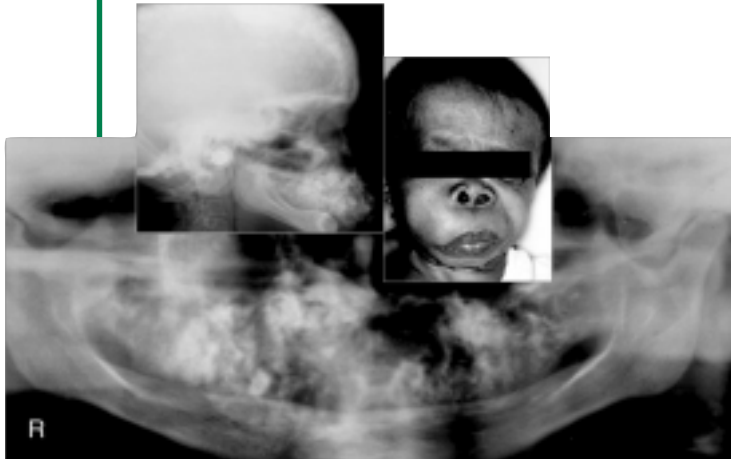
Fig. 6. Fibrous dysplasia: cropped panoramic radiograph showing mature (late) lesion of the left maxilla, obscuring the sinus. The lesion is radio-opaque with some radiolucent mottling. It has a ground (frosted) glass appearance. The lesion melds with the normal surrounding bone.

Primary malignancies affecting the maxillary sinus include squamous-cell carcinoma, adenoid cystic carcinoma and adenocarcinoma (7). The maxillary sinus may also be affected secondarily by extension malignancies of the oral soft tissues or jaw, and also, although rare, is the site of metastases from distant sites (8).

Owing to their radio-opacity, roots or whole teeth displaced into the sinus are readily apparent even when not centered within the image layer. These need to be differentiated from sinus bone nodules and antroliths (calcified “stones” arising in the antral lining) both of which entities could be mistaken for teeth or displaced roots (9). Foreign bodies, such as bullets, are clearly demonstrated; however care needs to be made to differentiate between clearly demarcated real images, and blurred magnified ghost images of foreign bodies or jewelry more distally and lower placed in or on the contralateral side of the face. Oroantral fistulas following dental extraction are only noticeable on panoramic radiography when large - and within the panoramic image layer.

Regarding inflammatory conditions of non-odontogenic origin, these are usually clearly demonstrated on panoramic radiography if they involve mucosal thickenings arising from the floor of the maxillary sinus. The most frequent example of such a process is the mucous retention phenomenon. This is seen as a smooth dome-shape swelling of the mucosa with homogeneous radiodensity. The sinus floor is not displaced or eroded. A mucous retention phenomenon is rarely

Fig. 7. Paget's disease of bone: Note cotton-ball radio-opaque sclerotic deposits. There is maxillary cortical expansion. The lesion is bilateral, crossing the midline (panoramic and lateral skull radiographs).



symptomatic; it requires no treatment. Antral polyps are only clearly demonstrated when situated in the panoramic image layer. This is rarely the case; hence, other radiographic views are preferred. Opacified sinuses or fluid levels may be found with acute sinusitis, which accompanies the common cold in 0.5-5% of cases (5;6).

The maxilla can also be the site of a variety of dysplastic and fibro-osseous conditions. Fibrous dysplasia can cause the partial or complete occlusion of the sinus on the affected side of the maxilla (Fig. 6). This may arise in young children and is usually apparent by adolescence. It is generally unilateral. By way of comparison, Paget's disease of bone can also cause occlusion of the sinus, but can affect both sides of the maxilla and is found in an aging population (Fig. 7). Cherubism may affect the maxillary tuberosities bilaterally as well as the mandibular rami. The lesions are initially multilocular radiolucencies and later sclerose.

Clinical Significance of Maxillary Sinus Disease

The early detection of insidious maxillary sinus disease can be very important for the patient's prognosis, especially in the case of malignant neoplasia. By the time of overt signs of squamous-cell carcinoma of the maxillary antrum (e.g. neck node metastasis or palatal fistula - Fig. 8 & 9), the five-year survival is only one in six (7). Substantial progress is being made with multi-modality treatment of cancer; hence, the dentist may well make a difference in



Fig. 8. Late stage maxillary sinus squamous-cell carcinoma eroding through the palate. Prognosis is poor. This patient has fixed cervical lymph nodes due to metastasis.

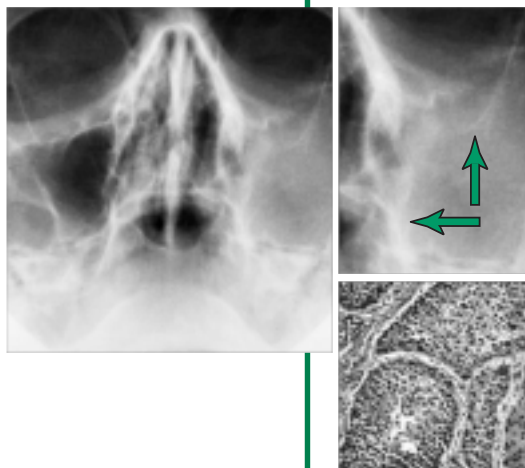


Fig. 9. Squamous-cell carcinoma: Water's view showing opacification of left maxillary antrum (sinus) with destruction of nasal and orbital walls (arrows).

“...the dentist may well make a difference in patient longevity by the early detection of cancer from astute reading of the panoramic radiograph.”

patient longevity by the early detection of cancer from astute reading of the panoramic radiograph (8). Early detection can result in an 80%, or better, treatment success rate as determined by 5-year survival (10,11). It has been found that panoramic radiography can demonstrate antral malignancy at the time of diagnosis in 90% of cases (12). However, occasional individual case reports do show that, dependent on the lesion's precise site, even large squamous cell carcinomas might be missed when relying on panoramic radiographs alone (13,14).

The prevalence of mucosal retention cysts in the maxillary sinus averages around 5%, but varies considerably from report to report, perhaps as a function of population, geography and season (15-18). The prevalence is approximately twice as high in men as in women. The detection and correct interpretation of the retention cyst is important for preventing unnecessary diagnostic procedures or surgical intervention (19). It has been demonstrated that the retention cyst, unlike the antral mucocele, has no relationship to sinus obstruction (20). Antral mucoceles are associated with osteal closure and complete sinus opacification, pain, jaw expansion and erosion of the antral outline (21, 22).

When dealing with panoramic radiographs, one needs to consider the possibility of ghost images being reflected well away from the actual lesion. This is particularly the case with highly radiopaque foreign bodies such as those associated with gunshot injuries (23).

Summary

The growth of tumors within the maxilla is not concentric; hence, the site of origin is not necessarily the epicenter of the lesion. The maxillary sinus, or antra, constituted the path of least resistance for the growth of such maxillary lesions as cysts and benign neoplasms. Even very large benign tumors and cysts might be present without resulting in clinically noticeable jaw expansion. Hence, the panoramic radiograph is of value in detection of unsuspected disease.

Antral malignancies are usually insidious and produce clinical signs and symptoms relatively late, when the prognosis is often quite poor. Panoramic radiographs have been found of utility in detection of antral carcinoma, particularly that affecting the posterior wall of the sinus (24). Caution should be used in that the panoramic radiograph is not the technique of choice for viewing the maxillary sinuses – however, it is incumbent on the dentist to evaluate the portion of the maxillary sinus shown in the panoramic radiograph made for other purposes. This might well be the first sign of disease and the only reason for pursuing further diagnostic tests. Early detection of such sinister occurrences improves the prognosis for the unfortunate patient.

There are limitations to the use of panoramic radiography in the detection of maxillary sinus disease; namely, only the areas within the selected image layer will be in focus. Experimental studies have shown that axial computed tomography provides a better evaluation of osteolytic lesions in the latero-superior or middle of the

posterior sinus wall than will panoramic radiograph (25,26). Lesions affecting the floor of the maxillary sinus are better identified and localized with panoramic films than with the Waters' projection (27). When dentists are reading the radiographs, panoramic radiographs have been found equal to Waters' projection for determination of sinusitis (28). These two techniques, and computed tomography, should be considered complementary rather than alternatives (1).

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In The Recent Literature:

Oral cancer: Panoramic radiography is a useful adjunct in evaluation of bone invasion by gingival squamous cell carcinoma.

Gomez D, Faucher A, Picot V, Siberchicot F, Renaud-Salis JL, Bussieres E, Pinsolle J. Outcome of squamous cell carcinoma of the gingiva: a follow-up study of 83 cases. *J Craniomaxillofac Surg* 2000 Dec;28(6):331-35. (From the Bergonie Institute, Regional Cancer Center, Bordeaux, France.)

Squamous cell carcinoma of the gingiva is relatively uncommon. Standard treatment involves surgery and/or radiotherapy. From 1985 to 1996, 83 patients with squamous cell carcinoma of the gingiva were treated at the Department of Surgery, the Bergonie Institute and at the Department of Maxillofacial and Plastic Surgery of the University Hospital, Bordeaux, France. A retrospective review of panoramic radiographs and clinical records was used to evaluate bone involvement

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from the gingival carcinomas. Outcomes were calculated using the Kaplan-Meier method. Primary local control was achieved in 72 patients (87%). Overall survival and rate of recurrence were comparable to those reported for other squamous cell carcinomas of the oral cavity and oropharynx.

Maxillofacial trauma: Panoramic radiographs proved significantly more reliable than mandibular film series for the detection of mandibular jaw fractures.

Nair MK, Nair UP. Imaging of mandibular trauma: ROC analysis. *Acad Emerg Med* 2001 Jul;8(7):689-95. (From the Department of Oral and Maxillofacial Radiology, University of Pittsburgh, Pittsburgh, USA.)

The objective of this study was to compare the diagnostic efficacy for detection of mandibular fractures of panoramic radiography versus mandibular trauma series presented both as analog and as digitized

radiographs. Fractures were induced using blunt trauma to 25 cadaver mandibles. Panoramic radiographs and mandibular series comprising an antero-posterior view, two lateral oblique, and a reverse Towne's projection were made. The mandibular series was viewed both in analog and in digitized forms. Six observers recorded their interpretations using a five-point confidence rating scale. The data was studied using receiver operating characteristic (ROC) curve analysis. Significant differences based on imaging modalities were found ($p < 0.0015$) in the area under the curves ($A(z)$): mandibular series, 0.75; digitized mandibular series, 0.77; panoramic radiograph, 0.87; and panoramic plus antero-posterior radiographs in combination, 0.89. No observer-based differences were found. Intra- and inter-observer agreements were high ($\kappa(w) = 0.81$ and 0.76 , respectively). It is concluded that panoramic radiographs are adequate for the detection of mandibular fractures. The addition of an antero-posterior view only marginally improved diagnostic accuracy.



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CE TEST: Pathologic conditions of the maxillary sinus

- The Waters' method uses an occipital-mental projection to demonstrate the maxillary sinuses.
 True False
- The gender ratio for the prevalence of mucosal retention cysts in the maxillary sinus is?
 a) 1M:1F b) 1M:2F
 c) 2M:1F d) None of the above
- With early detection the prognosis for 5 year survival of maxillary sinus squamous-cell carcinoma is improved to approximately?
 a) 100% b) 80%
 c) 60% d) 40%
- Which of the following lesion outlines occurs with the odontogenic keratocyst?
 a) Unilocular
 b) Crenulated
 c) Multilocular
 d) Any of the above
- Fibrous dysplasia is generally unilateral and tends to be detected during childhood or adolescence.
 True False
- Opacified maxillary sinuses from acute sinusitis is associated with the common cold with which of the following frequencies?
 a) 0.5-5% b) 10-15%
 c) 25-40% d) >50%
- Jaw swelling is a frequent first sign of early changes due to benign neoplasms affecting the maxillary sinuses.
 True False
- Trabeculation within multilocular tumors such as the myxoma and the ameloblastoma frequently obscured the maxillary sinus outline.
 True False
- Panoramic radiographs of the maxillary sinus clearly demonstrate the position of metallic foreign bodies and are not subject to confusing ghosting artifact.
 True False
- The image layer for panoramic radiography rarely if ever covers the entire maxillary sinus.
 True False

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