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A Comparison of Computed Tomography and Panoramic Radiography in Assessing Malignancy of the Maxillary Antrum

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Panoramic and computed tomographic images of 20 patients with antral malignancy were viewed separately and compared to determine the extent of bony destruction of the sinus walls seen in each film type. This study showed that panoramic radiographs can demonstrate antral malignancy at the time of diagnosis in 90% of cases. Panoramic radiographs possess the potential for identifying the need for further diagnostic procedures in evaluating the maxillary antrum. Health care workers should be aware of the value of panoramic radiographs in examining this region. Copyright © 1996 Elsevier Science Ltd

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INTRODUCTION

Computed tomography (CT) is the principal imaging modality for malignant disease of the maxillary antrum. On a CT scan the normal soft tissue structures can be seen, as well as the soft tissue component of a tumour [1]. Furthermore, a CT scan is able to accurately detect bone destruction of the maxillary sinus or structures around the sinus, such as the infra-temporal fossa, pterygopalatine fossa or the orbit, and will detect tumour invasion into muscle and soft tissue [1]. Panoramic radiography (PAN) is of value in detection of tumours and cystic lesions and it has been suggested that this image may be used in the detection of pathosis of the antrum [2–5]. It has been stated that panoramic radiography is a suitable technique for detection of maxillary sinus malignancy [3–6]. It is necessary to understand the anatomy of the maxillary antrum as visualised upon panoramic radiography if used for the detection of bony destruction of the sinus due to malignant tumours. The maxillary sinus has been described as a triangular pyramid with its base toward the nasal cavity and its apex extending into the zygomatic process [7–10]. The posterior border of the maxillary sinus is the infra-temporal fossa. The anterior border is the facial surface of the maxilla. The roof, or superior border, is the floor of the orbit. The medial aspect is the lateral wall of the nose (Fig. 1). This study was conducted to determine if destruction of the maxillary antrum can be detected on panoramic radiography in a series of patients with antral malignancy.

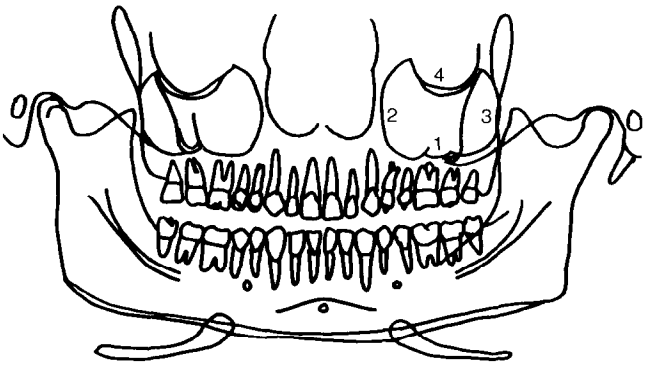

Fig. 1. Boundaries of antrum demonstrated on panoramic radiographs. (1) Inferior border; (2) medial border; (3) posterior (lateral) border; (4) orbital floor.

METHOD

The patient register of the British Columbia Cancer Agency was reviewed to identify patients diagnosed with antral malignancy between 1985 and 1993. Criteria for patient selection included the availability of pretreatment PANs, and CTs prior to therapy (i.e. surgery, radiation, and chemotherapy). The panoramic radiographs were made on a General Electric (GE) Panelipse machine (Milwaukee, Wisconsin, U.S.A.) using X-Omat R.P. Panoramic DF-75 5 × 12 in. film (Eastman Kodak, Brazil). The CT scans made

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Table 1. Patient demographics, tumour stage and therapy

Patient no.	Sex	D/M/Y	Histopathology	Stage		Treatment			RT Dose (cGy)
				Sys	Stage	Surgery	RT*	Chemo†	
			Squamous cell carcinoma						
2	F	30/01/26	Squamous cell carcinoma	TNM	3, X, 0	Yes	Yes	No	5000
4	M	15/02/28	Squamous cell carcinoma	TNM	3, 0, 0	No	Yes	No	4500
5	M	28/05/03	Squamous cell carcinoma	TNM	4, 0, 0	Yes	Yes	No	5000
6	M	15/09/23	Squamous cell carcinoma, lare cell, non-keratinising type	TNM	4, 0, 0	Yes	Yes	No	5000
7	F	09/08/31	Squamous cell carcinoma	TNM	4, 3, 0	No	Yes	Yes	5000
9	F	10/04/01	Squamous cell carcinoma	TNM	3, 0, 0	No	Yes	No	5000
11	F	21/09/22	Carcinoma, anaplastic type	TNM	3, 0, 0	Yes	Yes	No	6000
13	M	28/08/40	Squamous cell carcinoma	TNM	3, 0, 0	Yes	Yes	Yes	5500
14	M	14/06/31	Squamous cell carcinoma	TNM	3, 0, 0	Yes	Yes	No	5000
15	F	02/11/23	Squamous cell carcinoma *in situ*	TNM	3, 0, 0	Yes	Yes	No	5000
17	M	14/04/20	Squamous cell carcinoma	TNM	2, 0, 0	Yes	Yes	No	5000
19	M	25/03/35	Squamous cell carcinoma	TNM	2, 0, 0	Yes	Yes	No	5000
			Lymphoma						
1	M	09/05/35	Reticulosarcoma, malignant lymphoma, immunoblastic type	BCCI	1AE	Yes	Yes	No	3000
8	F	20/01/26	Malignant lymphoma, large cell, non-cleaved, diffuse	BCCI	1BE	No	No	Yes	—
10	F	01/11/19	Reticulosarcoma, malignant lymphoma, follicular centre cell, non-cleaved	BCCI	2AE	No	Yes	Yes	4500
12	F	11/02/03	Malignant lymphoma, large cell, non-cleaved, diffuse	BCCI	1AE	Yes	No	Yes	—
			Miscellaneous						
3	M	17/05/06	Transitional cell carcinoma	TNM	4, 0, 0	Yes	Yes	No	1250
16	F	01/08/72	Alveolar rhabdomyosarcoma, embryonal enne, rhabdomyosarcoma	—	—	Yes	Yes	No	5940
18	M	29/09/47	Chondrosarcoma	Ennek	2B	Yes	No	No	—
20	F	10/02/27	Adenocarcinoma	TNM	X, 0, 0	Yes	Yes	No	5000

Classification system: *RT = radiation therapy; †Chemo = chemotherapy.

Table 2. Walls of sinus on panoramic radiographs

Patient no.	Inferior	Medial	Posterior/lateral	Orbit floor	Adjacent alveolar bone
			Squamous cell carcinoma		
2	Destroyed	Destroyed	Intact	Intact	Destroyed
4	Destroyed	Destroyed	Destroyed	Intact	Destroyed
5	Destroyed	Equivocal	Intact	Intact	Intact
6	Destroyed	Destroyed	Intact	Intact	Destroyed
7	Destroyed	Equivocal	Intact	Intact	Destroyed
9	Destroyed	Destroyed	Intact	Equivocal	Destroyed
11	Intact	Equivocal	Intact	Equivocal	Intact
13	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
14	Equivocal	Equivocal	Intact	Equivocal	Intact
15	Equivocal	Destroyed	Destroyed	Destroyed	Destroyed
17	Destroyed	Destroyed	Intact	Equivocal	Equivocal
19	Destroyed	Destroyed	Intact	Intact	Destroyed
			Lymphoma		
1	Destroyed	Intact	Destroyed	Intact	Destroyed
8	Destroyed	Destroyed	Destroyed	Intact	Destroyed
10	Destroyed	Destroyed	Destroyed	Intact	Destroyed
12	Destroyed	Destroyed	Intact	Equivocal	Destroyed
			Miscellaneous		
3	Destroyed	Equivocal	Intact	Equivocal	Equivocal
16	Destroyed	Intact	Intact	Intact	Destroyed
18	Equivocal	Intact	Destroyed	Equivocal	Equivocal
20	Intact	Destroyed	Intact	Intact	Intact

Table 3. Walls of sinus on computed tomograph

Patient no.	Inferior	Medial	Posterior	Orbit floor	Adjacent alveolar bone
			Squamous cell carcinoma		
2	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
4	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
5	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
6	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
7	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
9	Destroyed	Destroyed	Destroyed	Intact	Destroyed
11	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
13	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
14	Intact	Destroyed	Intact	Destroyed	Intact
15	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
17	Intact	Destroyed	Intact	Intact	Intact
19	Intact	Intact	Destroyed	Intact	Destroyed
			Lymphoma		
1	Destroyed	Destroyed	Destroyed	Intact	Destroyed
8	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
10	Destroyed	Destroyed	Intact	Equivocal	Destroyed
12	Destroyed	Destroyed	Intact	Destroyed	Intact
			Miscellaneous		
3	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
16	Destroyed	Destroyed	Intact	Intact	Intact
18	Destroyed	Destroyed	Destroyed	Intact	Destroyed
20	Destroyed	Destroyed	Intact	Equivocal	Intact

Table 4. Assessment of walls of maxillary sinus visualised on panoramic radiographs and computed tomography

	Inferior	Medial	Posterior/lateral	Orbit floor	Adjacent alveolar bone
			Panoramic radiographs		
% destruction	75%	60%	35%	10%	65%
% intact	10%	15%	65%	55%	20%
% equivocal	15%	25%	0%	35%	15%
			Computed tomography		
% destruction	85%	95%	70%	60%	75%
% intact	15%	5%	30%	30%	25%
% equivocal	0%	0%	0%	10%	0%

between 1985 and 1990 were acquired on a G.E. 8800 machine (Milwaukee, Wisconsin, U.S.A.). Those made between 1990 and 1993 were acquired on a G.E. 9800 Hi-Lite machine (Milwaukee, Wisconsin, U.S.A.). Contiguous images at 5 mm intervals were acquired in the axial and/or coronal planes. The majority of the CTs were done without intravenous contrast. However, when constrast was used, a 100 ml bolus of Omipaque 350 (Sanofi-Winthrop, Markham, Ontario, Canada) was placed by injection. PANs and CTs were available for 20 patients subsequently diagnosed with maxillary sinus malignancy and were independently studied by a dentist, a specialist in oral medicine, and by a radiologist. The information recorded from the medical record included: age, gender, histology, stage of tumour, treatment rendered, and the current status of the patient. Tumor staging was completed by the patient's oncologist. Squamous cell carcinoma was staged using the TNM classification [11], sarcoma was staged as described by Pazdur and Baker (Ennek) [12], and lymphoma staged according to the Committee on Hodgkin's Disease classification (BCCI) [13].

The quality of the PAN was rated by the clarity of the image at three different locations: the condyle and coronoid process, the posterior alveolar processes in both arches, and the anterior alveolar process in both arches. A rating of excellent, fair, or poor was given to each area of the film to determine the quality of the imaging. Numerical values were assigned (i.e. excellent = 3, fair = 2, poor = 1) and an average was calculated to represent the overall quality of each film. The boundaries of the sinus were defined as the inferior wall, medial wall, posterior (lateral) wall, and the orbital floor, which represented the roof of the sinus (Fig. 1).

The status of the adjacent alveolar process was also considered. Analysis of the PAN and CT images were carried out to determine whether each boundary was either destroyed, intact, or deemed to be equivocal. Destruction was assumed if there was a break in the continuity of the wall or if the entire wall appeared to be missing. When there was disagreement between investigators, these results were deemed equivocal. If it was not possible to detect destruction or verify that a particular wall was intact, it was also labelled equivocal. When opacification was seen in the PAN or CT, this was recorded together with other miscellaneous findings.

Table 5.

Patient no.	Soft tissue mass visualised on panoramic radiograph: Opacification	Size of mass within antrum (cm)	Mass beyond sinus	Assessment of maxillary sinus on computed tomograph: % of sinus occupied by mass	Mass	Other
				Squamous cell carcinoma		
2	Yes	3 × 1	Yes	100	Yes	Direct extension inferiorly into the infra-temporal fossa inferiorly and laterally to mandibule and soft tissue of cheek. Medially it crosses palate, posteriorly pterygoid plate destruction; on panoramic: irregular destruction of the posterior aspect of ramus
4	No	—	No	100	Yes	Posteriorly into nasopharynx and intra-temporal fossa. Anteriorly into soft tissue of cheek. Medially into nasal cavity
5	Equivocal	—	No	100	Yes	Ethmoid and nasal cavity and nasopharynx also sphenoid bone and air cells
6	Yes	—	Yes	100	Yes	Extension superiorly and medially into the ethmoid air cells and nasal cavity, Inferiorly and posteriorly into the infra-temporal fossa. Anteriorly into the soft tissue of the cheek
7	No	—	Yes	100	Yes	Mass localised to sinus
9	Yes	—	No	100	Yes	Anterior extention into the soft tissue of the cheek. Medial extension into the nasal cavity. Posterial extension into the nasopharynx. Laterial extension into infra-temporal fossa
11	Yes	2.5 × 2	No	100	Yes	Medially into nasal cavity destruction of vomer crosses midline inferiorly extend to nasopharynx
13	Yes	—	Yes	100	Yes	Extend laterally into soft tissue cheek. Medially into nasal cavity extend superiorly into brain; on panoramic: pathology on right opacification on left
14	Equivocal	—	No	100	Yes	Medial extention into ethmoid sinus
15	Yes	2.5 × 2	Yes	100	Yes	Extends inferiorly and laterally into pterygopalative fossa, infra-temporal fossa and nasopharynx medially into ethmoid sinus and nasal cavity. Superiorly into left orbit and sphenoid sinus
17	Yes	—	No	30	No	Mucosal thickening; on panoramic: contrast dye seen in sinus
19	No	—	No	30	Yes	Laterally into zygomatic bone
				Lymphoma		
1	No	—	No	70	Yes	No extension of mass, it is localised
8	No	—	Yes	100	Yes	Inferiorly into alveolar bone and pterygoid fossa. Laterally into soft tissue of cheek. Medially into orpharynx and tongue. Superiorly into right orbit
10	Yes	4.5 × 2.5	Yes	—	No	Sclerosis of zygoma
12	Yes	2.5 × 1	No	50	Yes	Mucosal thickening
				Miscellaneous		
3	Yes	4 × 3.5	Yes	100	Yes	Massive ethmoid and air cell and nasal cavity involvement
16	No	—	No	100	Yes	Anteriorly into soft tissue of cheek; medially if extends to the nasal cavity and nasopharynx
18	Yes	4 × 3	No	100	Yes	Medially extends to nasal cavity to left antrum. Inferiorly to oral pharynx. Superiorly if extends to the sphenoid sinus and through cribiform plate
20	Yes	—	No	100	Yes	Medial extension into nasal cavity. Crosses vomer and extends to left nasal cavity posteriorly into nasopharynx and anteriorly into nares

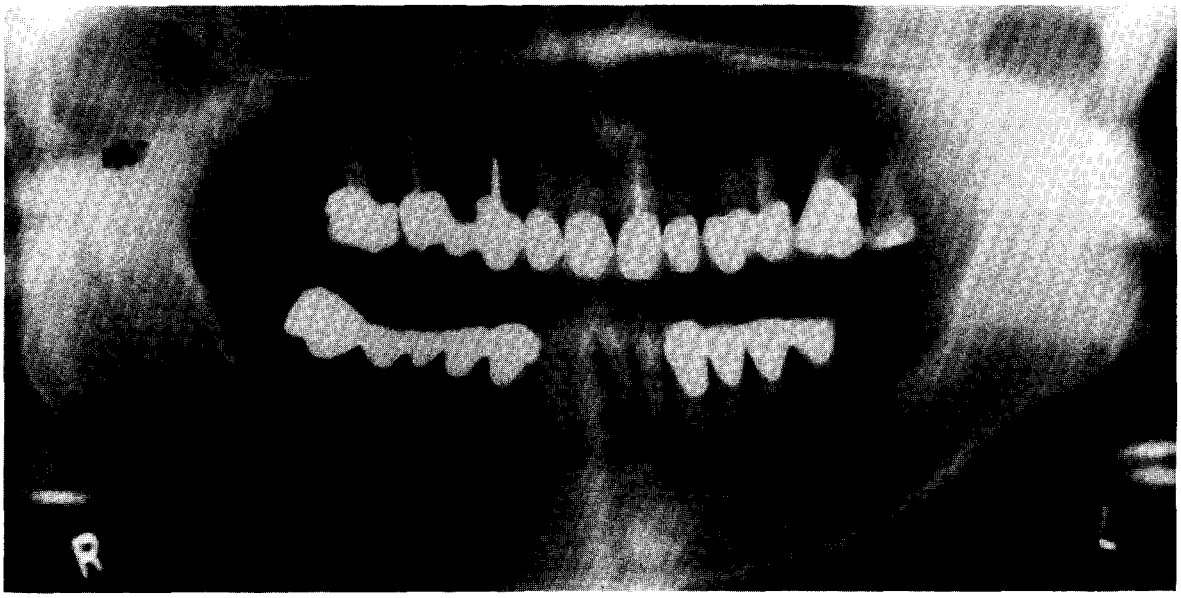

Fig. 2(A). Panoramic radiograph demonstrating destruction of the inferior and posterior walls and adjacent alveolar bone on the right-hand side.

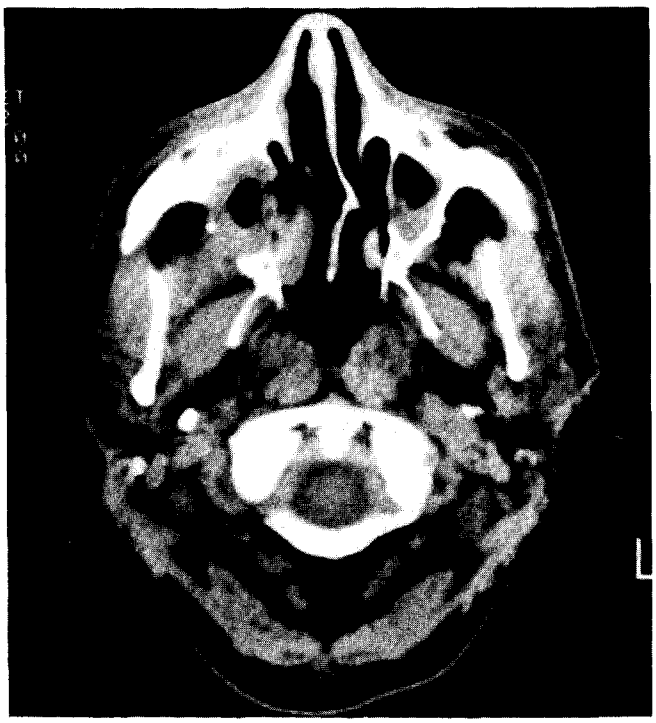

Fig. 2(B). CT scan demonstrating destruction of the medial and lateral walls of the antrum with involvement of the anterior wall. A soft tissue mass occupies the majority of the antrum and appears to extend laterally.

RESULTS

The age, gender, histology, staging, and treatment rendered are shown in Table 1. The quality of the PANs were judged to be excellent or good. Eleven PANs rated an overall score of 3, three a score of 2, and the others fell between a score of 2 and 3. The average quality of all the films was a score of 2.7. The period of time that elapsed between acquiring the PANs and CTs ranged from 1 day to 3 months (mean of 26 days) with the exception of one case where 7 months had elapsed.

Destruction of at least one of the walls of the sinus was seen on the PAN in 90% of cases which was subsequently confirmed on the CT films (Tables 2–4). A mass that extended beyond the antral walls was seen on 40% of the PANs (Table 5). On the CT, a mass which involved the entire sinus and extended beyond the borders of the antrum was seen in 70% of the cases (Table 5). Opacification of the sinus was apparent on the panoramic radiograph in 60% of the cases. The inferior border correctly showed destruction 76% of the time on the PAN (Table 5) when compared to the CT (Tables 2 and 3). The medial wall destruction was correctly detected on 58% of the PANs (Tables 2–4). The posterior wall destruction was correctly detected on 43% of the PANs (Tables 2–4). Destruction of the orbit floor was correctly identified on only 17% of PANs (Tables 2–4). Destruction of an adjacent alveolar process was correctly detected in 73% of cases (Tables 2–4). When viewing the PAN (Table 4), the inferior wall of the antrum was most commonly seen to be destroyed, whereas on the CT scans the medial wall was most commonly seen to be destroyed (Table 4). Opacification of the sinus was seen in the majority of cases (Table 5). The overall sensitivity of PAN compared to CT was calculated at 90%, when any destructive change of antral anatomy was accepted as positive evidence of malignancy.

CASE REPORTS

A series of case reports is presented to illustrate the findings upon imaging to provide examples of radiographic findings in patients with malignancy of the maxillary antrum. In these cases, one or two CT images were chosen as representative of each case which of course do not document the full extent of disease demonstrated on multiple CT cuts.

Fig. 3(A). Destruction of the left antral floor and alveolar process. Destruction of the posterior and medial wall of the antrum and posterior aspect of the mandibular ramus is also seen.

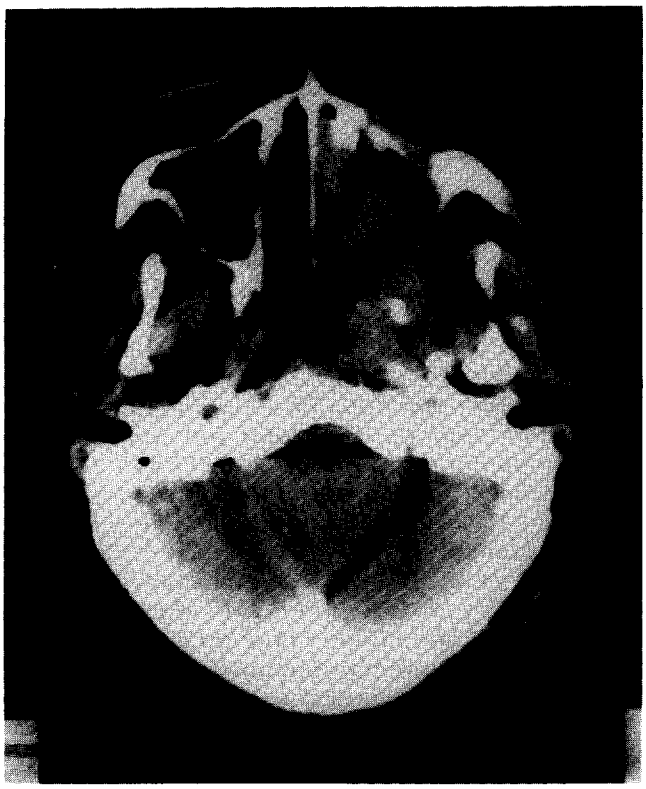

Fig. 3(B). Destruction of all antral walls and mass extending from the midline towards the nasopharynx and infra-temporal fossa on the left-hand side.

Case 1

This patient was a 50-year-old male with reticulosarcoma and immunoblastic lymphoma. The destruction of the inferior and posterior walls and adjacent alveolar bone are seen on the PAN on the right side (Fig. 2A). The medial wall and the orbital floor appear to be intact. The CT (Fig. 2B) reveals the destruction of the anterior, medial, and posterior walls along with adjacent alveolar process destruction. The orbit floor appears intact. A mass which was not seen in the PAN is localised to the sinus, of which it occupies approximately 70%.

Case 2

A 68-year-old female was diagnosed with squamous cell carcinoma of the left antrum. On the PAN (Fig. 3A) an opacification is seen in the left antrum, which was measured (without correction for magnification) to be approximately 3 cm in width and 1 cm in height. A soft tissue mass is seen which extends beyond the sinus. There is also irregular destruction of the posterior aspect of the left ramus. Destruction is seen on the left side of the inferior and medial walls, as well as of the adjacent alveolar bone. The posterior wall and orbit floor appear intact. On the CT (Fig. 3B) all of the boundaries of the sinus are destroyed. A mass fills the entire sinus cavity, into the infra-temporal fossa, to the midline and into the soft tissue of the cheek.

Case 3

A 55-year-old female with squamous cell carcinoma of the left antrum was seen. Destruction of the inferior wall and of adjacent alveolar bone was identified on the PAN (Fig. 4A). The examiners were unable to determine the status of the medial wall. The CT (Fig. 4B) shows extensive bony destruction involving all the antral walls and a mass occupies the entire sinus.

Case 4

This case was a 66-year-old female with lymphoma. In the right sinus (Fig. 5A) destruction of all antral borders is seen

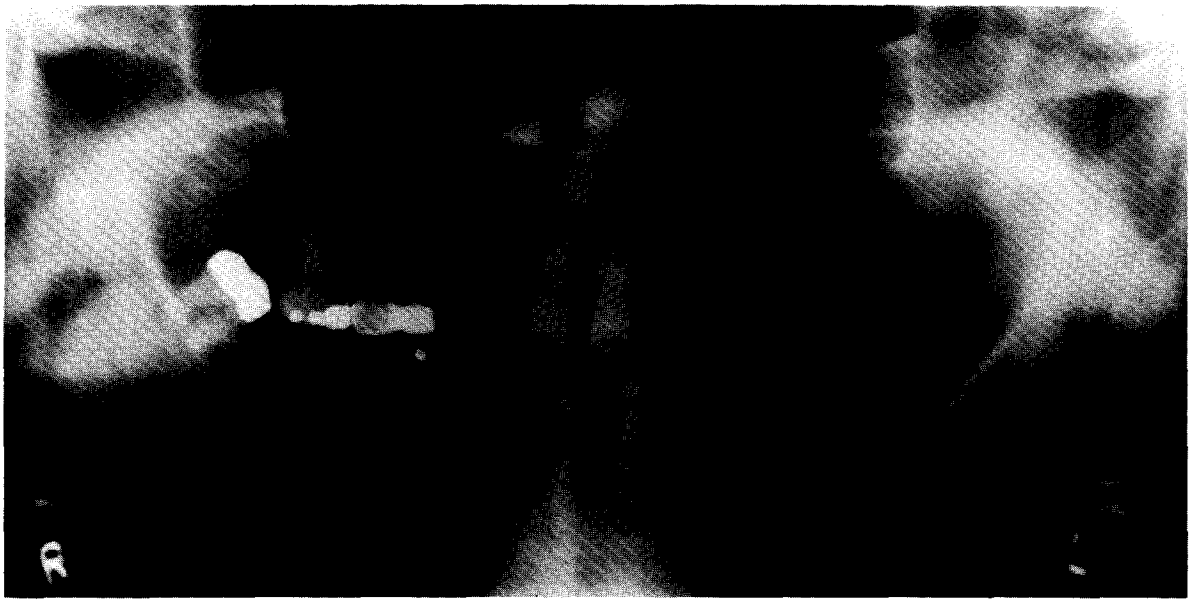

Fig. 4(A). Massive destruction of the inferior and posterior walls of the sinus is shown on the left.

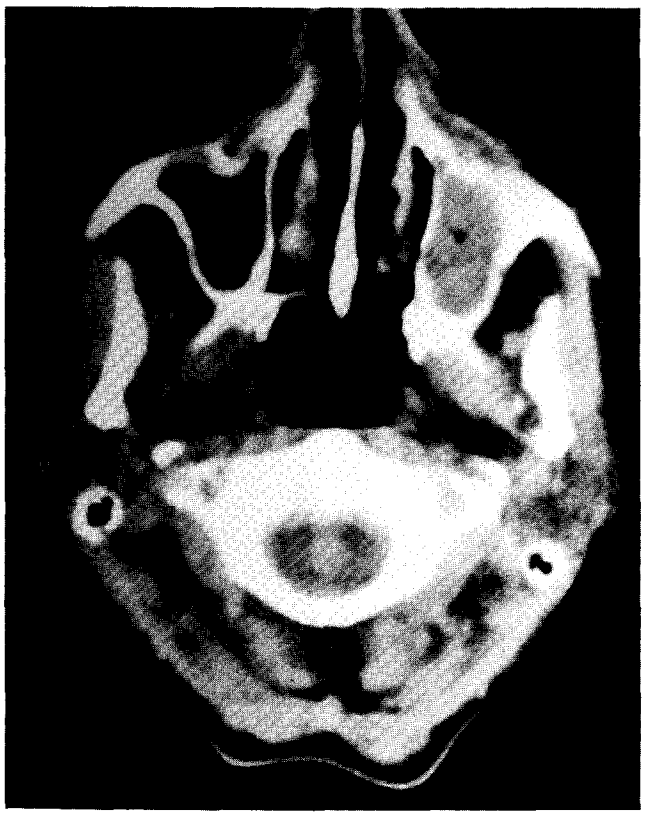

Fig. 4(B). Opacification of the antrum and areas of low attenuation of the antral wall are visible on the left-hand side.

on PAN films except for the orbit floor. A soft tissue mass is seen extending beyond the sinus. On the CT (Fig. 5B) all the borders are destroyed. This example demonstrates the use of the PAN for the detection of massive bony destruction of the maxillary sinus. A tumour mass is seen extending inferiorly into the alveolar bone and pterygoid fossa, laterally into the soft tissue of the cheek, medially into the oropharynx and tongue, and superiorly (Fig. 5C) into the right orbit.

Case 5

A 61-year-old female with squamous cell carcinoma of the left antrum was seen. The PAN (Fig. 6A) shows a soft tissue mass extending beyond the confines of the sinus. Medial and posterior walls appear destroyed, as well as the floor of the orbit and adjacent alveolar bone. The inferior wall was equivocal in this regard. On the CT (Fig. 6B), extensive destruction is noted. A tumour mass is seen extending inferiorly and laterally into the pterygopalatine fossa and infra-temporal fossa and nasopharynx, medially it extends into the ethmoid sinus and nasal cavity. Superiorly the mass extends into the left orbit and sphenoid sinus.

Case 6

A 65-year-old female diagnosed with adenocarcinoma of the right sinus was seen. On the PAN (Fig. 7A) an opacification is seen on the right. All of the borders of the sinus appeared intact except destruction of the medial wall. The CT (Fig. 7B) shows destruction of the anterior and medial walls. The examiners were unable to determine the status of the floor of the orbit. A tumour mass is seen extending into the nasal cavity and crosses the midline. Posteriorly it extends into the nasopharynx and anteriorly into the nares. This is another example where the destruction is more extensive on the CT when compared to the PAN.

DISCUSSION

The analysis of the quality of the PANs indicated that good to excellent quality films were available. The average time that elapsed between taking the PAN and CT films allowed comparison of the two sets of films.

The most common walls of the maxillary antrum to be

Fig. 5(A). No borders of the antrum other than the orbital floor are seen. A soft tissue mass extends beyond the antrum as visualised in the area where the tuberosity was present on the right-hand side.

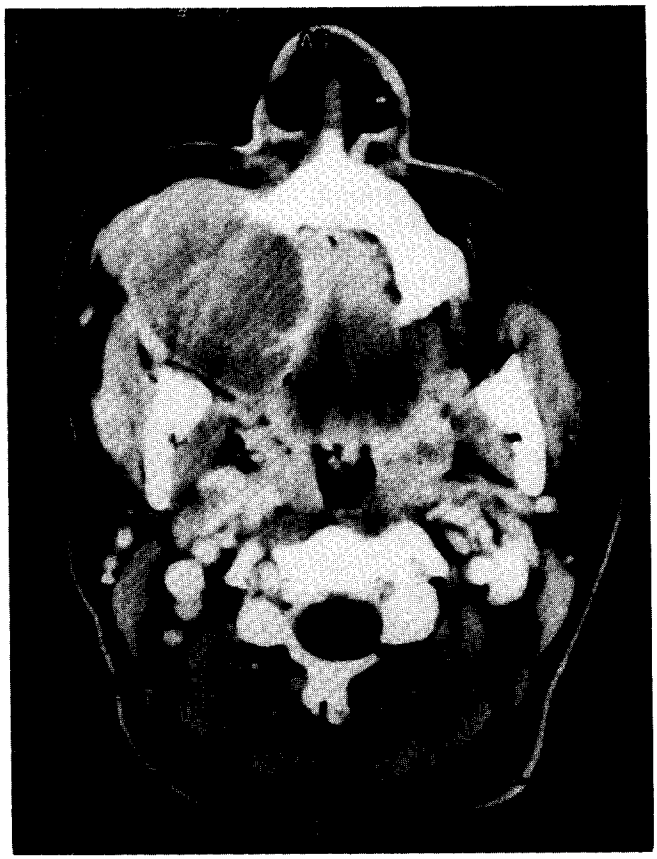

Fig. 5(B). Massive destruction of the antrum and alveolar process with extension of the mass into the cheek and medially to the palate.

Fig. 5(C). Massive antral destruction with invasion of the right orbit.

destroyed were the medial and inferior wall (Table 4). Our findings show that the overall sensitivity of the PAN was 90% compared to CT in detecting abnormality in patients with antral malignancy. On the PAN, the inferior border was imaged well (77% sensitivity). The orbit floor was not imaged well (17% sensitivity) but some of this may be attributed to patient positioning in the unit (i.e. orbital floor was not recorded on film due to patient position in 6 out of the 20 cases). In the cases presented, the walls were affected, the alveolar bone may be involved and soft tissue masses were seen on the panoramic films. The CT scans frequently demonstrated greater destruction of adjacent bone than the panoramic films and extension of tumour masses into adjacent soft tissue. CT scan demonstrated soft tissue mass on the

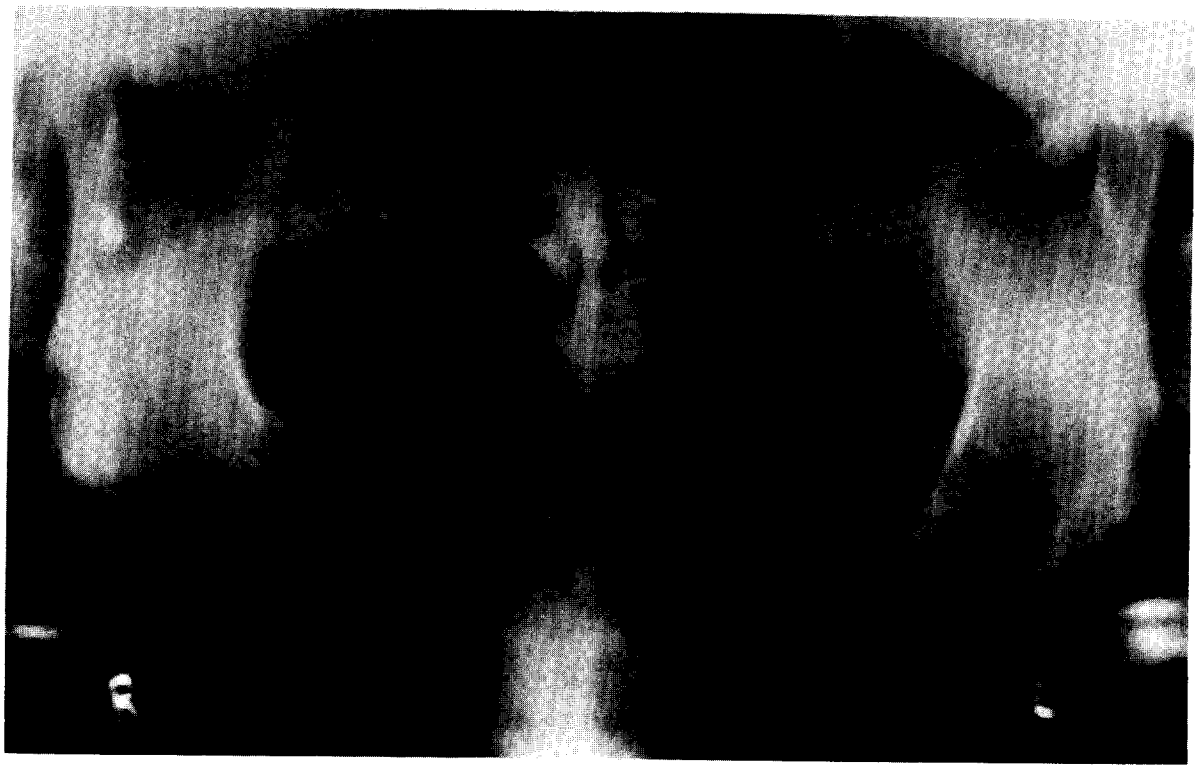

Fig. 6(A). Panoramic film with irregular destruction of the alveolar process and tuberosity and inferior and posterior wall of the antrum. A soft tissue opacity is visible inferiorly to the left zygoma.

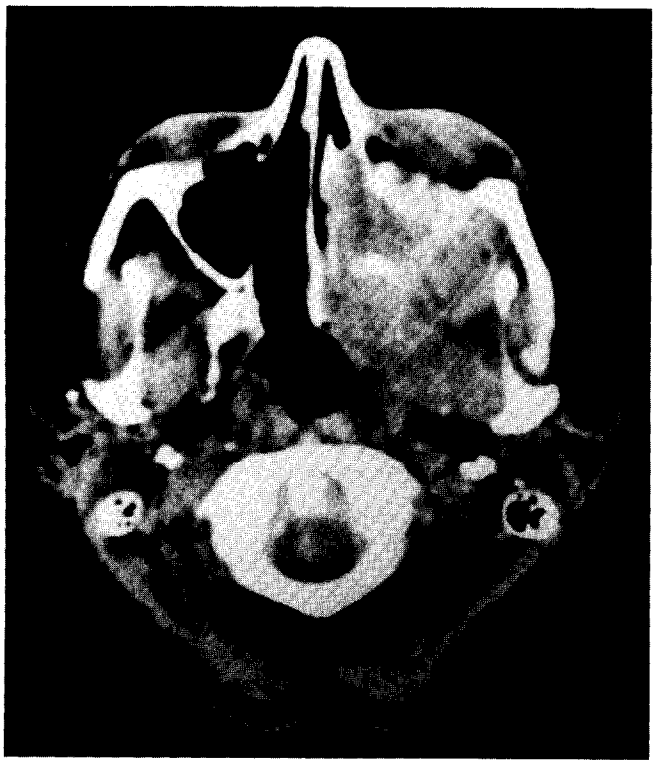

Fig. 6(B). Extensive destruction of the antral walls with a mass extending to the midline of the nose and involvement of the regions posterior and laterally to the antrum.

antrum in 95% of cases, but this was only visualised in 35% of PANs. Thus, while panoramic radiography may be considered as a preliminary study, imaging by CT scan is required for further investigation.

Our findings show that patients with antral cancer are usually identified with locally advanced disease and with bone destruction (Table 1). The most recent update of the computer files (May 1994) showed that 10 patients were alive, 4 of these patients without disease, and 6 had disease but their status was unknown. 10 patients were not alive and the cause of death was antral carcinoma in 6 of these patients. 12 of the 20 cases had a histology of squamous cell carcinoma (SSC). 4 of these patients had histology of lymphoma, 1 chondrosarcoma, 1 adenocarcinoma, 1 rhabdomyosarcoma, and 1 transitional cell carcinoma. Of the 12 patients who had squamous cell carcinoma, 2 were alive without disease, 3 were alive and their status was unknown, 5 were deceased (cause of death antral cancer), and 2 were deceased due to causes other than antral cancer.

Greenbaum and associates reported that PANs were better than routine radiography for visualising the extent of tumour invasion of the posterior wall of the maxillary sinus [14]. Shramek and Rappaport suggested that PANs may be used as a screening device for pathosis in the maxillary antrum [3]. Panoramic radiography is also useful in otorhinolaryngology [3, 6, 14]. The study reported here further supports the use of PANs for detection of malignancy in the sinus. Often it is the dentist who has the opportunity to observe pathology in the maxillary sinus, through panoramic radiography, in a symptomatic or asymptomatic patient. This should lead to referral

Fig. 7(A). All borders of the antrum other than the medial wall on the right-hand side appear intact.

Fig. 7(B). Destruction of the medial wall of the antrum with an extensive mass opacifying the antrum and involving the nose crossing the midline.

for further investigation, such as CT and biopsy, to confirm the diagnosis. This may result in reduced morbidity and mortality due to earlier detection [3]. In this study, an antral malignancy which was visible on a CT scan was seen on a PAN 90% of the time. This should alert health care professionals to examine this region carefully as this may aid the detection of tumours of the antrum.

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