

The value of panoramic radiography in assessing maxillary sinus inflammation

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ABSTRACT

Purpose: To evaluate the value of panoramic radiography in diagnosing maxillary sinus inflammation.

Materials and Methods : A total of 214 maxillary sinuses from 114 panoramic radiographs were assessed in this study. Two independent experienced oral radiologists evaluated the images in random order for sinus inflammation. Using Cone beam CT images as the gold standard, the sensitivity and specificity of panoramic radiography were calculated, and inter- and intraobserver agreement for panoramic interpretation were obtained.

Results : The mean sensitivity and specificity of panoramic radiography were 81.0% and 85.6%, respectively. The weighted kappas for inter- and intraobserver agreement of panoramic radiography were 0.56 and 0.60, respectively.

Conclusion : Panoramic radiography is a reasonably accurate method for diagnosing maxillary sinus inflammation and can be used for screening. However, additional examinations should be considered in patients with potentially significant pathology. (*Korean J Oral Maxillofac Radiol* 2008; 38 : 215-8)

KEY WORDS : Maxillary Sinus; Radiography, Panoramic; Cone-Beam Computed Tomography

Introduction

Maxillary sinus inflammation is a common clinical problem and radiography is frequently used to diagnose it.¹⁻⁴ Computed Tomography (CT) is the examination of choice to evaluate sinusitis.^{5,6} However, it is costly and involves greater radiation exposure than plain radiographs. These features limit its application.^{7,8}

The Cone Beam (CB) CT for maxillofacial imaging was introduced in the late 1990s.^{9,10} It provides opportunities for dental practitioners to obtain multiplanar imaging. Earlier studies¹¹⁻¹⁴ have shown that CBCT offers great advantages compared to conventional CT in depicting the maxillofacial region, in terms of accuracy, scan time reduction, dose reduction and cost. CBCT is primarily designed for hard-tissue visualization of the maxillofacial region and has low soft-tissue resolution. But from clinical experience, we found no difficulties in using it to identify maxillary sinus inflammation.

Even though plain radiography is known to have limited value for imaging paranasal sinuses,^{4,7,15-22} it is still used due to its comparatively low cost, availability, and ease of exami-

nation. Waters' view is considered optimal for assessing the maxillary sinuses. The most posterior and inferior aspects of the antrum, however, may be obscured by the maxillary alveolar process and posterior teeth in this view.

Panoramic radiography has been used as a screening imaging modality for routine examinations of the teeth and the jaws. Maxillary sinuses, though not their full extent, are easily recognized on panoramic radiography, which can be a useful adjunct for viewing the maxillary sinuses. Small changes outside the imaging layer (focal trough) are not visible. In the normal panoramic projection, the roof of the maxillary sinus is not viewed. Panoramic radiography is known to be a better radiologic approach than Waters' projection to detect lesions on the posterior wall or floor of the maxillary sinus^{23,24} and the mucosal thickening is usually well demonstrated.^{24,25}

There have been several reports on using panoramic radiography to detect maxillary sinus disease,^{23,25-28} but little information on the diagnostic performance for maxillary sinus inflammation has been published. It is said that panoramic radiography is not a technique for the examination of maxillary sinusitis.²⁴ However, the introduction of digital panoramic radiography has brought a considerable improvement in image quality.

The purpose of this study is to compare the diagnostic reliability of panoramic radiography with CBCT, which is the gold standard for detecting maxillary sinus inflammation.

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Materials and Methods

1. Materials

The CBCT examination archives of Pusan National University Hospital from January 2007 to April 2008 were reviewed for cases which had panoramic radiography and CBCT images taken on the same day. We excluded cases which were suspected of having non-inflammatory disease in the maxillary sinus area. A total of 214 maxillary sinuses from 114 patients were eligible for the study (58 males, 56 females; age range 20-70 years, mean age 44.5 years).

2. Image acquisition and Assessment

1) Image acquisition

Digital panoramic radiographs were taken using PM 2002 CC Proline (Planmeca Oy., Helsinki, Finland) with the standard panoramic program. The radiographic settings were 62-64 kVp, 5-6 mA, and 18 s exposure time.

All CBCT scans were performed with DCT Pro (Vatech, Kihung, Korea) consisting of an X-ray tube, a source collimator and an amorphous-silicon flat-panel detector. CBCT scans were performed with a rotation of 360 degrees for data acquisition. The exposure factors were Field of view 20 × 19 cm, 90 kVp, 4-5 mA, and 24 s exposure time. Images were reconstructed using a high spatial frequency reconstruction algorithm. The acquired image data consists of a 14-bit scale.

2) Image assessment

First, the panoramic images were interpreted independently by two experienced oral radiologists in a blinded fashion. Observer A evaluated the images twice with a time interval of at least 1 month between each reading, and observer B evaluated them once.

Radiological criteria for sinusitis were classified as 0=normal, 1=thickening of mucosa (≥2 mm and <6 mm), 2=partial opacification (≥6 mm but not full), 3=full opacification. Mucosal thickening was evaluated by measuring the distance between the air-mucosal interface and the inner bony margins of the sinus. The sinus was considered normal when the mucosal thickening was less than 2 mm.

3) Statistical analysis

The weighted kappa statistics²⁹ were computed to assess inter- and intraobserver agreement for the interpretation of the panoramic radiography. For interobserver agreement, data were used from the first assessment of both observers. For intraobserver agreement, data from the first and second assess-

ments of observer A were used.

Kappa statistics are commonly interpreted as <0.00, poor agreement; 0.00 to 0.20, slight agreement; 0.21 to 0.40, fair agreement; 0.41 to 0.60, moderate agreement; 0.61 to 0.80, substantial agreement; and 0.81 to 1.00, almost perfect agreement. For each kappa index, 95% confidence intervals were also calculated using standard error value and the values that cut off 2.5% of the normal distribution.

To calculate the sensitivity and specificity, we dichotomized the results into two groups: normal group, score 0; and pathology group, score 1-3. The CBCT images served as the gold standard. Two oral radiologists diagnosed the CBCT images together and reached a consensus without any dispute.

Results

The CBCT examination was negative for sinusitis in 93 of 214 maxillary sinuses. Of the 93 normal cases, panoramic radiography showed a matched diagnosis rate of 86.0%. On the other hand, matched diagnosis rate for full opacification was only 8.3% (Table 1).

The weighted kappa indexes for inter- and intraobserver

Table 1. Panoramic and Cone Beam CT interpretation in 214 maxillary sinuses

	Panoramic radiography				Total	Matched diagnosis (%)	
	0	1	2	3			
CBCT	0	80	11.5	1.5	0	93	86.0
	1	17	54.5	6.5	0	78	69.9
	2	5.5	6.5	25	0	37	67.6
	3	0.5	1.5	3.5	0.5	6	8.3
Total	103	74	36.5	0.5	214		

0, Normal; 1, Mucosal thickening; 2, Partial opacification; 3, Full opacification

Table 2. Inter- and intraobserver agreements of panoramic radiography

	Weighted kappa index
Interobserver	0.56 (0.46-0.66)*
Intraobserver	0.60 (0.51-0.70)*

*95% confidence interval

Table 3. Sensitivity and specificity of panoramic radiography with Cone Beam CT images as reference standard

	Sensitivity	Specificity
Observer A	75.2	87.2
Observer B	86.8	83.9
Mean	81.0	85.6

agreement were 0.56 and 0.60 respectively, showing a moderate agreement (Table 2).

The sensitivity and specificity of the panoramic examinations were 81.0% and 85.6%, respectively (Table 3).

Discussion

Maxillary sinus inflammation is commonly encountered by dental practitioners. Even though CT has been generally accepted as the most reliable imaging method for detecting sinusitis, it has a number of disadvantages, mainly cost and high-level radiation exposure. The rapid development and improvement of CBCT equipment has made it possible to maintain the diagnostic quality of images at a much lower radiation dose, greater ease of examination, and lower cost than CT scanners. Today, CBCT are widely used for a variety of indications in the dental field.^{11,30-35}

Although CBCT has limitations in demonstrating soft tissue abnormalities, the soft tissue surface and air space can be evaluated. Yamashina et al.³⁶ reported that the measurement of the air cavity distance surrounded by soft tissue was accurate with both CBCT and MDCT. We can easily differentiate between the soft tissue and the air on CBCT images. To avoid giving more radiation to the patient, we decided to use previously taken CBCT images from clinical necessity as our gold standard.

Panoramic radiography is a basic imaging modality for almost all patients having dental or maxillofacial problems, and unsuspected antral diseases may be detected during routine use of this procedure.³⁷ In this study, we used not the sinus projection program but the standard panoramic program because we tried to find out how much information we could get from a routine panoramic checkup.

The results showed that the diagnosis of normal is the most reliable with panoramic radiography. Among 93 normal cases, panoramic radiography indicated false positive findings in 13 cases, most of which were wrongly interpreted as thickening of mucosa. On the other hand, considerable cases of mucosal thickening showed false-negative findings with panoramic radiography. The main reason for difficulty in discriminating between normal and mucosal thickening is attributed to the groove for the posterosuperior alveolar vessel and nerve. It gives a linear shadow on the maxillary sinus, which could be confused with the mucosa-air demarcation line.

Panoramic radiography resulted in the lowest incidence of matched diagnosis when the sinuses were completely opacified. We could only guess complete opacification from the hazy

images because panoramic radiography does not show the entire maxillary sinus. Complete opacification is usually present in acute sinusitis, the diagnosis of which is primarily based on clinical findings. It is recommended that panoramic findings should be interpreted in light of signs and symptoms.

To assess reliability and consistency, we computed weighted kappa. By considering mean weighted kappas of 0.56-0.61, it can be stated that there was moderate agreement. There is no report of panoramic radiography on this issue to compare with our results. The previous studies^{21,22,38,39} showed that the inter- or intraobserver agreements of Waters' view in assessing maxillary sinus varied from fair to almost perfect. Differences seem to be related to diverse study designs.

The sensitivity of the present study was approximately 81%, indicating that in approximately 19% of the cases, a diagnosis of sinusitis was missed. The specificity of the present study was about 87%, which means the false-positive rate was 13%. The sensitivity of panoramic radiography was generally higher and the specificity was a little lower than those of sinus plain films.^{7,16,40,42} The present study suggests that panoramic radiography is a reasonably accurate method for evaluating maxillary sinus inflammation even though a clear sinus on a panoramic projection does not consistently rule out the existence of maxillary inflammatory disease and vice versa.

In summary, panoramic radiography may not be reliable enough to assist with clinical decision making. But considering the fact that clinical signs are not always associated with typical radiographic findings,³⁸ a panoramic radiography taken for dental purpose can be used as a screening tool for maxillary sinus inflammation. If the severity of patient illness requires diagnostic certainty, more sensitive imaging studies, such as CT scans of the sinuses, should be considered.

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