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Diagnosing acute maxillary sinusitis in primary care: A comparison of ultrasound, clinical examination and radiography*

Karri Laine[1], Tuomo Määttä[2], Helena Varonen[3], Marjukka Mäkelä[3]

[1] Nurmijärvi Health Centre, Nurmijärvi, Finland
[2] Kajaani Health Centre, Kajaani, Finland
[3] Department of Services and Quality, National Research and Development Centre for Welfare and Health (Stakes), Helsinki, Finland

SUMMARY

In primary care, acute maxillary sinusitis may be diagnosed by clinical examination, ultrasound or radiography. Previous studies on the diagnostic accuracy of these methods are from secondary care settings and may not be generalisable to primary care. In this study of 39 primary care patients we have compared ultrasound, clinical examination and radiography to sinus irrigation. The sensitivity of ultrasound performed by general practitioners is 61% and specificity is 53%. Diagnostic accuracy does not improve when the general practitioner bases the diagnosis on combination of clinical examination and ultrasound. The most accurate way to diagnose sinusitis is radiography and when the radiographs are interpreted by a radiologist (sensitivity: 61%; specificity: 98%). The accuracy of the ultrasound examination performed by general practitioners is poorer than earlier results from ENT practices. More attention should be paid to education and quality management in the use of ultrasound in primary care.

Key words: acute maxillary sinusitis, diagnosis, ultrasound, radiography, clinical examination

INTRODUCTION

Acute maxillary sinusitis is one of the most common diseases general practitioners diagnose and treat. Diagnosing acute maxillary sinusitis is not always simple and various opinions on the accuracy of the current diagnostic methods have been presented (Gleeson, 1992; Druce, 1992; Williams and Simel, 1993; Evans, 1994). In primary care, acute maxillary sinusitis may be diagnosed by clinical examination, radiography, ultrasound, sinus puncture or with a combination of these methods.

Ultrasound has become a popular diagnostic method for acute maxillary sinusitis during the last two decades. In Finnish primary care, it is used in 82-92% of presenting cases to diagnose acute maxillary sinusitis (Mäkelä and Leinonen, 1996). Ultrasound has certain properties of an ideal diagnostic method: it is safe, quick, inexpensive and easily repeated. The estimates of the accuracy of ultrasound in ENT practices have been good. Accuracies exceeding 90% have been reported (Revonta, 1980; Jannert et al., 1981; Katholm et al., 1984). Studies from ENT practices may not be generalisable to primary care, due to differences in patient populations and severity of disease. Ultrasound results also depend largely on the examiner's skills: General practitioners consider ultrasound difficult to interpret (Mäkelä and Leinonen, 1996).

This study was designed because there are no reports on the efficacy of ultrasound compared to sinus aspiration or irrigation in primary care settings. Van Buchem et al. (1995) reported a study comparing ultrasound and radiography to sinus puncture in primary care. However, in that study sinus puncture was performed only in a subgroup of patients. Our primary aim was to determine the efficacy of ultrasound performed by a general practitioner in diagnosing acute maxillary sinusitis.

PATIENTS AND METHODS

Patients

The study took place in two middle-sized primary-care units in Finland, covering populations of 30,000-37,000 people. In Kajaani Health Centre the study period was from October 1992 to March 1993, and in Nurmijärvi Health Centre it was during October 1992 and February 1993. Consecutive acute patients over 15 years of age, suspected of having acute maxillary sinusitis were included in the study. The suspicion could be raised by the patient, nurse or general practitioner. Patients were excluded for the following reasons: symptoms for more than 30

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days, pregnancy, previous maxillary surgery or unwillingness to participate.

General design

Twelve general practitioners in Kajaani and Nurmijärvi Health Centres recruited patients for the study. After informed consent from the patient, the general practitioners on duty took the patient's history, did the clinical and ultrasound examinations and recorded their clinical diagnosis based on this information. Sinus radiographs were subsequently taken. Next, one of the two principal investigators recorded a short history, performed anterior rhinoscopy and ultrasound examination, and irrigated the sinuses. The principal investigator did not have any information from the general practitioner on duty, but he did have the sinus radiographs.

The patients received both written and oral information on the procedures of the study and gave their oral consent. The study was accepted by the Ethical Committee of the Medical School of Oulu University.

Symptoms and signs

The general practitioner on duty recorded the patient's history, symptoms and signs. History covered the number of earlier sinus infections and sinus irrigations, allergic rhinitis, antimicrobial medication during the preceding 30 days, and the duration of symptoms. Symptoms of nasal obstruction, purulent discharge, pain in sinuses/forehead, cacosmia, hyposmia, cough and fever were observed. Signs of nasal mucosal thickening, purulent secretion in the throat or nasal cavities, purulent cough, sinus tenderness and cheek pain in bending were checked, and possible unilaterality of signs and symptoms was noted.

Ultrasound

We used the ultrasound device Sinuscan 101 (manufactured by Oriola) with a frequency of 3 MHz and a transducer diameter of 8 mm. The five units used were either newly acquired or checked according to the manufacturer's instructions. This type of device had been used for six years in Nurmijärvi Health Centre. In Kajaani Health Centre another type of ultrasound equipment had been used for several years. At the beginning of this study the physicians in Kajaani Health Centre got the standard information on the use of the Oriola Sinuscan from the manufacturer. The general practitioners on duty did not use any written material in their interpretation of the findings. They classified the findings as normal, mucosal thickening, maxillary sinusitis or unclear. In the analysis, sinuses with only mucosal thickening were classified as normal and those with unclear findings were excluded.

Radiography

The radiographical examination consisted of three standard projections (occipito-frontal, occipito-mental and lateral projections). The radiographs were later interpreted by a radiologist under blind conditions. The radiologist had neither the clinical information, nor the results of sinus irrigations or ultrasound examinations.

Reference standard

Sinus irrigation was performed as soon as possible after the ultrasound and radiographical examinations. Most of the sinus irrigations were done by the two principal investigators (K.L. or T.M.), who have long experience in this intervention. Two other general practitioners performed the puncture on four patients (altogether seven sinuses). Topical anaesthesia (4% lidocaine and 0.1% adrenalin) was used and antral lavage was performed with at least 100 ml of warm 0.9% saline solution. If the antral lavage contained either purulent or mucopurulent material, the patient was diagnosed as having acute maxillary sinusitis. The puncture material categories were: "+" for width of floccule $<$0.5 cm; "++" for width of floccule 0.5-2 cm; and "+++" for width of floccule $>$2 cm or purulent fluid.

Statistical analysis

We calculated the sensitivity, specificity, accuracy, positive and negative predictive values and likelihood ratios (LR) for the three diagnostic methods (general practitioner's ultrasound, the combination of overall clinical impression and ultrasound, and the radiologist's interpretation of sinus X-rays) compared to sinus irrigation. We based the calculations on the number of sinuses examined and controlled with sinus irrigation. For variables in history, symptoms and signs the two-tailed Fisher's exact test with a significance level of 0.05 was performed. The median waiting time from the general practitioner's examination to sinus irrigation was also calculated.

RESULTS

A total of 62 patients was eligible to participate in the study. One patient was excluded for symptoms exceeding 30 days, 15 patients did not give their consent, four patients were excluded because of too long a period (more than two days) before gold standard verification, and two patients were excluded for failure to follow the study protocol. One patient was excluded because of unclear ultrasound results from both sinuses. The patient material consisted finally of 39 patients. The patients were aged 16-68 years (median: 37 years). Twenty-six patients (67%) were women. Seventy-two sinuses were punctured in 39 patients; two of the 78 sinuses could not be punctured, and for four sinuses the ultrasound result was unclear or lacking. The delay from the ultrasound examination to sinus irrigation was 1-32 h (median: 2 h).

In nine punctures the patient experienced moderate pain and in 24 cases slight pain; 43 punctures were painless. One puncture was discontinued due to bleeding and pain and another patient had transient nasal bleeding ending spontaneously after the intervention. Five patients experienced dizziness or tremor. No other complications occurred.

Symptoms and signs

The frequencies of items in history, symptoms and signs are shown in Table 1. Nasal obstruction and sinus or frontal pains were the most common symptoms in this population. Patients without sinusitis had fever more often than patients with sinusitis ($p=0.02$). Otherwise, no significant differences were found in the frequencies of symptoms among diseased and healthy groups.

Table 1. Frequency of items in history, clinical symptoms and signs in patients with sinusitis and patients without sinusitis.

items in history:	patients with sinusitis (n=20) n (%)	patients with no sinusitis (n=19) n (%)
number of earlier instances of sinusitis	14(70)	16(84)
number of earlier sinus irrigations	8(40)	8(42)
allergic rhinitis	4(20)	4(21)
animicorbial medication during the preceding 30 days	1(5)	1(5)
duration of symptoms	average 12(median 10)	average 7 (median)
symptoms:		
nasal obstruction	16(80)	16(84)
purulent discharge	12(60)	9(47)
cough	9(45)	10(53)
ache in sinuses/forehead	16(80)	16(84)
ache in teeth	7(35)	4(21)
cacosmia	2(10)	1(5)
hyposmia	8(45)	4(21)
temperature > 38C	0(0)	5(26)*
unilateral symptoms	6(30)	4(21)
signs:		
nasal mucosal thickening	11(55)	14(74)
purulent secretion in throat	0(0)	1(5)
purulent secretion in nasal cavities	6(30)	3(16)
purulent cough	1(5)	1(0)?
sinus tenderness	9(45)	9(47)
cheek pain in bending	9(45)	8(42)
unilateral signs	3(15)	2(11)

* p=0.02

Ultrasound

The results of the sinus ultrasound examinations performed by the general practitioners are presented in Table 2. The general practitioner was able to make the correct diagnosis with the aid of ultrasound in slightly more than half of the cases. The results were not dependent on the severity of findings in sinus irrigation. This was verified by testing different cut-off points in the interpretation of sinus irrigation findings. The accuracy of ultrasound was reduced mainly by the high numbers of false-positive diagnoses (32%). Almost all of these findings were negative also in radiography (21 negative, one cyst, and one maxillary retention). There was also a remarkable number of false-negative diagnoses with the ultrasound. Of the 23 sinuses with retention, nine sinuses (39%) were missed. In radiography, six cases of these nine were positive for sinusitis.

Overall clinical impression and ultrasound

The results of the general practitioners' final clinical impression based on symptoms, signs and ultrasound are summarized in Table 2. The sensitivity was better (70%) than with ultrasound alone, but the number of false-positive diagnoses was also higher (43%).

Radiography

The accuracy of the radiologists' interpretation of the sinus X-rays is presented in Table 2. Radiography was a very specific method to diagnose sinusitis (specificity 98%). Three of the false-negatives had signs of mucosal thickening, one was a cyst and five were normal.

Table 2. The accuracy of the three diagnostic methods compared to sinus puncture for detection of sinusitis.

	sinus puncture +	sinus puncture –	total
a) general practitioner ultrasound			
ultrasound +	14	23	37
ultrasound –	9	26	35
b) ultrasound combined with clinical information			
overall impression +	16	31	47
overall impression –	7	18	25
c) radiologist interpretation of sinus X-rays			
X-ray +	14	1	15
X-ray –	9	48	57
total	23	49	72

Table 3. Comparison of results.

	sensitivity %(95% CI)	specificity % (95% CI)	PPV %	NPV %	accuracy %	LR+	LR–
US compared to SP	61(45-77)	53(39-67)	38	74	56	1,3	0,9
Combination of clinical examination and US compared to SP	70(56-83)	37(23-50)	34	72	47	1,1	1,7
X-ray (radiologist's) compared to SP	61(36-86)	98(94-100)	93	84	86	29,2	0,02

US: ultrasound; SP: sinus puncture; CI: confidence interval; PPV: positive predictive value; NPV: negative predictive value; LR+: likelihood ratio for positive result; LR–: likelihood ratio for negative result.

Comparison of results

The results of ultrasound alone, ultrasound combined with clinical examination, and the radiologists' interpretation of X-rays are collected in Table 3. Ultrasound did not improve general practitioners' ability to diagnose acute maxillary sinusitis (LR: 1.3). With the aid of clinical information the likelihood ratio became even lower (LR: 1.1). These methods did not change meaningfully the diagnostic accuracy in cases of acute maxillary sinusitis in this setting. Radiography as interpreted by experienced radiologists seems a very precise method for diagnosing sinusitis (LR: 29.2).

DISCUSSION

We have succeeded in recruiting only a modest number of patients. This is partly due to fear of sinus puncture, which has been the most common reason for withdrawal. Because of the small sample the results must be treated cautiously. Nevertheless, the strength of the material is in representing a typical primary-health-care population. The investigators are average general practitioners and their diagnostic performance reflects the current situation in primary care.

The accuracy of ultrasound compared to sinus puncture was 56% in this study. This is much below the results ENT specialists have reported (Revonta, 1980; Jannert et al., 1981). However, there are certain problems with previous studies of ultrasound use in the diagnosis of acute maxillary sinusitis. Instead of sinus irrigation the reference standard in many cases has been radiography (Shapiro et al., 1986; Landman, 1986; Dobson et al., 1996) and in some cases only sinuses with radiographic sinus pathology have been verified with a reference standard (Katholm et al., 1984; Jensen and Von Sydow, 1987). The better results may be explained partly by verification bias.

A major reason for the modest accuracy estimates in our study was the number of false-positive diagnoses. Due to imperfect examination techniques general practitioners may interpret normal anatomy as sinusitis. Another reason could be the interpretation of mucosal thickening as retention, although this was not the case in our material. Sinus cyst explained the false-positive diagnosis in one case. Sinus neoplasms may simulate sinusitis, although in our material no tumours were found.

According to our study, symptoms and clinical signs are not of much use in the diagnosis of sinusitis. Other studies have reached the same conclusion (Axelsson and Runze, 1976; Hansen et al., 1995). Radiographs interpreted by an experienced radiologist have been the most accurate method for diagnosing sinusitis in our study. However, radiography is not an ideal diagnostic method for primary care sinusitis, as it is not always available in primary care when needed.

The use of clinical information in addition to ultrasound did not increase the diagnostic accuracy. General practitioners tend to diagnose acute maxillary sinusitis very sensitively, leading to a large number of false-positive diagnoses. More education and practice in using the ultrasound device in primary care could improve the situation. ENT specialists may reach better results in ultrasound accuracy because of more practice, but also because of better knowledge of facial anatomy. Also, the disease prevalences in secondary care are generally higher than in primary care.

The diagnosis of acute maxillary sinusitis is not yet adequately studied in primary care settings. The most recent studies have highlighted the difficulties in finding an efficient diagnostic strategy (Van Buchem et al., 1995; Hansen et al., 1995). A major problem in studying the diagnosis of acute maxillary sinusitis in primary care is the lack of good reference methods. Sinus puncture is the gold standard of diagnosis, but in many health care cultures it is considered unethical to perform sinus irrigation without knowledge of sinus pathology. In Finland, sinus puncture is well accepted and also used sometimes as a diagnostic method for acute maxillary sinusitis. Radiography may not be accurate enough to be a gold-standard method (Varonen and Mäkelä, 1997). Computed tomography has been used as a reference standard in some studies (Hansen et al., 1995), but its disadvantages are the cost and number of false-positive diagnoses in healthy people (Calhoun et al., 1991).

Our study suggests that currently the quality of diagnosing sinusitis in primary care is inadequate, the main threat being the large number of false-positive diagnoses. Ultrasound could help the primary care physician in ruling out sinusitis, but more attention should be paid to education and quality management in the use of ultrasound. Although a common diagnostic method for a common public health problem, ultrasound has been studied very little in primary care settings. More research is needed on methods for improving the efficacy of diagnosing sinusitis in primary care.

CONCLUSIONS

The accuracy of the ultrasound examination performed by general practitioners is much weaker than the results reported from ENT practices. With this efficacy ultrasound does not improve the general practitioners' diagnostic accuracy compared to clinical examination only. Studies on larger patient populations and on the effects of training general practitioners in the use of ultrasound in acute maxillary sinusitis are needed.

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Dr. Helena Varonen
Stakes
Department of Services and Quality
P.O. Box 220
FIN-00531 Helsinki
Finland

ANNOUNCEMENT

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June 30 through July 3, 1998, Utrecht, The Netherlands

From June 30–July 3, 1998 a course in functional aesthetic nasal surgery will be given at the University of Utrecht, The Netherlands, under the direction of Dr. J.A.M. de Groot and Dr. A.F. van Olphen. The Course will consist of lectures, TV-demonstrations, cadaver dissection and live TV-surgery.

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