

Diagnostic value of plain radiographs in chronic maxillary sinusitis: A comparison between radiological and endoscopic findings in 75 patients

J.E. Laranne¹, M.A. Penttilä, T.A. Paakkala², J.S. Pukander¹ and P.H. Karma³

¹ Dept. Otolaryngology, University Central Hospital, Tampere, Finland

² Dept. of Radiology, University Central Hospital, Tampere, Finland

³ Dept. of Otolaryngology, University Central Hospital, Helsinki, Finland

SUMMARY

Preoperative radiologic and intraoperative endoscopic findings of maxillary and ethmoid sinuses were compared in 75 adult patients, in whom 135 chronically inflamed maxillary sinuses were operated using functional endoscopic sinus surgery (FESS). At sinoscopy, secretion was found in 91% (41/45) of the radiologically opacified antra and in 47% (31/65) of the antra with moderate or marked mucosa/swelling in plain radiographs. Antral fluid level in radiographs was a relatively rare (23%) finding and showed secretion as reliably as opacification. Radiographic detection of secretion in maxillary sinuses with mucosa! thickening is difficult. There was a fair correlation in both antral and ethmoidal mucosa! changes with the mucosa! findings in antroscopy and endoscopic ethmoid surgery.

INTRODUCTION

Sinus radiographs have until recently been the primary method in evaluating the condition of paranasal sinuses. Several authors have suggested that antroscopy could in many cases replace X-ray examination in diagnosing maxillary sinus diseases (Illum et al., 1972; Pfleiderer et al., 1986; Gilbert, 1989). Antroscopy seems to be superior to plain radiographs in detecting antral secretion and it also gives more exact information for differential diagnosis (Illum et al., 1972; Pfleiderer et al., 1986; Gilbert, 1989). Modern functional endoscopic sinus surgery (FESS) stresses the important role of the ostiomeatal unit of the ethmoid

This study has been, in part, presented at the 13th Congress of the European Rhinologic Society, London, 24-29 June 1990.

in the pathogenesis of sinusitis. Exact evaluation of the anatomically complex ethmoid area is rather difficult on plain radiographs. This is due to superimposed anatomical structures, nasal secretions and variations of radiographic techniques (Pollei and Harnsberger, 1989).

The aim of this study was to evaluate the findings of plain sinus radiographs in patients with chronic maxillary sinusitis with reference to maxillary and ethmoid sinus status obtained during antroscopy and FESS.

MATERIAL AND METHODS

The studied group comprised of 75 adult patients (45 females and 30 males; aged 16-84 years, median 46 years), in whom 135 chronically inflamed maxillary sinuses (60 bilateral and 15 unilateral) were operated in the Department of Otolaryngology at the University Hospital of Tampere (Finland) between 1987 and 1989, using the endoscopic middle meatal technique. The inclusion criterion was a duration of symptoms of at least three months, despite active medical and irrigation treatment. The average number of antral irrigations within the preoperative year was 6.4 irrigations/patient. This material has been analyzed previously for other purposes (Penttilä et al., 1989a, b; 1990a, b).

Analysis of the radiographs

Standard, plain sinus radiographs were taken one day before surgery in three projections (lateral, occipito-frontal and occipito-mental views), and analyzed subsequently by one senior radiologist (TP), who had no knowledge of the patient's histories or the endoscopic findings.

The radiologic findings of the maxillary sinuses were classified with regard to mucosal swelling and the presence or absence of fluid level and polyps or cysts. Well-defined, dense, curved and usually solitary shadowings situated near the base of the maxillary sinus were regarded as cysts. The somewhat more diffuse, usually multiple and more randomly situated shadowings were considered to be polyps. The shadowing of the ethmoid air cells was similarly evaluated, normal/slight cloudiness, moderate cloudiness or completely opaque air cells. Both maxillary and ethmoid sinuses were evaluated separately.

Antroscopy

The endoscopic surgery was always started with the diagnostic sublabial fossa canine antroscopy using 5-mm trocar and 4-mm 30- and 70-Hopkins rod telescopes. Secretions, if present, were removed by suction, taking notes of their nature and amount. Further records were made of the condition of the antral mucosa and the presence and size of antral polyps/cysts. Solitary polyps were classified as small when the diameter was less than 1 cm, and large when it was greater than 1 cm.

Nasal endoscopy and FESS

Antroscopy was followed by nasal endoscopy and endoscopic middle meatal surgery. The operation was carried out gradually to the extent as needed in each individual case: removal of the uncinate process, enlargement of the maxillary ostium, opening and removing the walls of the ethmoid bulla, opening of the frontal recess, opening of the posterior ethmoid cells and opening of the sphenoid. The ethmoid mucosa was classified as normal or slightly, moderately, or strongly thickened. After the uncinate process had been removed, the patency of the infundibular canal was evaluated as open or slightly, moderately, or totally obstructed. In cases where the ethmoid bulla was opened, the thickening of its mucosa and presence of intrabullar secretion was recorded. The extent of ethmoid surgery (anterior, middle, posterior) and sphenoid surgery were also noted. All surgical procedures were performed by one ENT-surgeon (MP).

Radiological and endoscopic findings were recorded into study files and the data was analyzed using the StatPac Gold microcomputer programme.

RESULTS

Maxillary sinus

The radiological and antroscopic diagnosis of the status of the antral mucosa was identical in 55% (74 out of 135) of the sinuses (Table 1).

Table 1. Antral mucosa in X-ray vs. antroscopic mucosa! findings.

mucosa in sinus X-ray	mucosa in antroscopy			
	none/slight	moderate/ marked	impacted	total
normal or slightly swollen	16	8	0	24
moderately or markedly swollen	19	43	4	66
opacified	0	30	15	45
total	35	81	19	135

Radiologically false-positive and false-negative diagnoses of the mucosa! condition were found in 36% and 9%, respectively. None of the findings were, however, totally contradictory. At least a moderate amount of fluid was antroscopically found in 91 % (41 out of 45) of the radiologically opacified antra (Table 2). When the mucosa was classified as moderately or markedly swollen, fluid was found in 48%. In cases with radiologically normal or slightly swollen mucosa fluid was found in 33%.

A fluid level was radiologically seen in 31 out of 132 sinuses. The sensitivity and specificity of the radiographs in detecting fluid was 27% and 87%, respectively

(Table 3). Purulent secretion was somewhat more reliably detected (7 out of 18; i.e. 39%), whereas mucous or serous fluid seems to be harder to detect radiologically (18 out of 65; i.e. 28%).

Table 2 Antral mucosa in X-ray vs. antroscopic fluid finding.

preoperative sinus X-ray	amount of fluid in antroscopy			
	none/slight	moderate/ marked	impacted	total
normal or slightly swollen mucosa	16	8	0	24
moderately or markedly swollen mucosa	34	27	4	65
opacified	4	17	24	45
total	54	52	28	134

Table 3. Preoperative sinus X-ray vs. fluid in antroscopy.

fluid level in X-ray	fluid in antroscopy					
	none	slight	moderate	marked	filled	total
no	28	16	18	16	23	101
yes	4	6	12	6	3	31
total	32	22	30	22	26	132

Concerning polyps, the radiographs gave a false-negative diagnosis in 67% of the cases (66 out of 98) (Table 4). In most of these cases, however, the antral mucosa was simultaneously seen to be moderately or markedly swollen, or the antra were totally opacified. Sensitivity of the radiographs in diagnosing polyps was 27%, and specificity was 74%.

Table 4. Antral polyps in sinus X-ray and antroscopy.

antral polyps in X-ray	polyps in antroscopy				
	no	small polyps	large polyps	occluded by polyps	total
no	32	20	25	21	98
yes	9	7	16	2	34
total	41	27	41	23	132

Ethmoid sinuses

The radiological diagnosis of the ethmoid mucosa was identical with the endoscopic findings in 57% (73 out of 129 cases) (Table 5). The amount of false-positive and false-negative findings was 26% and 18%, respectively.

Table 5 Radiologic findings of ethmoid sinuses and ethmoid mucosa in FESS.

radiologic ethmoid findings	ethmoid mucosa in FESS			
	normal or slight swelling	moderate swelling	heavy swelling	total
normal/slight cloudiness	35	12	3	50
moderate cloudiness	18	21	8	47
opaque	2	13	17	32
total	55	46	28	129

During FESS the ethmoidal infundibulum was found to be obstructed in 122 cases. In 83% of the cases (102 out of 122) the cause of the obstruction was either polyps or swollen mucosa. In the rest of the cases the cause of the obstruction was thought to be an anatomical variation, usually a pathological uncinate process (9 cases; Figure 1) or a pneumatized middle turbinate (13 cases; Figure 2). The reason for the obstruction could not be detected on the plain radiographs.

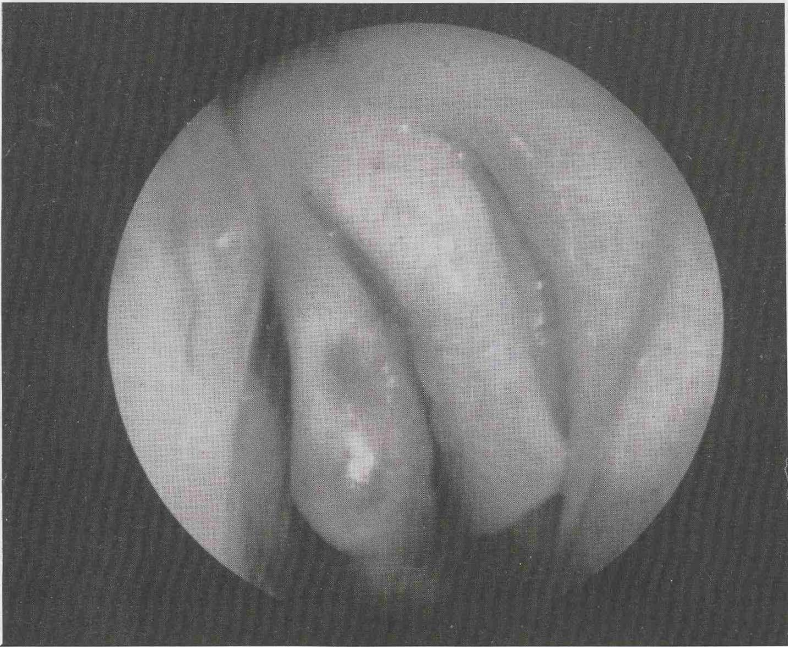


Figure 1 Anteromedially-bent, free posterior end of the uncinate process on the left, thought to be the cause of infundibular obstruction and chronic maxillary sinusitis in this case.

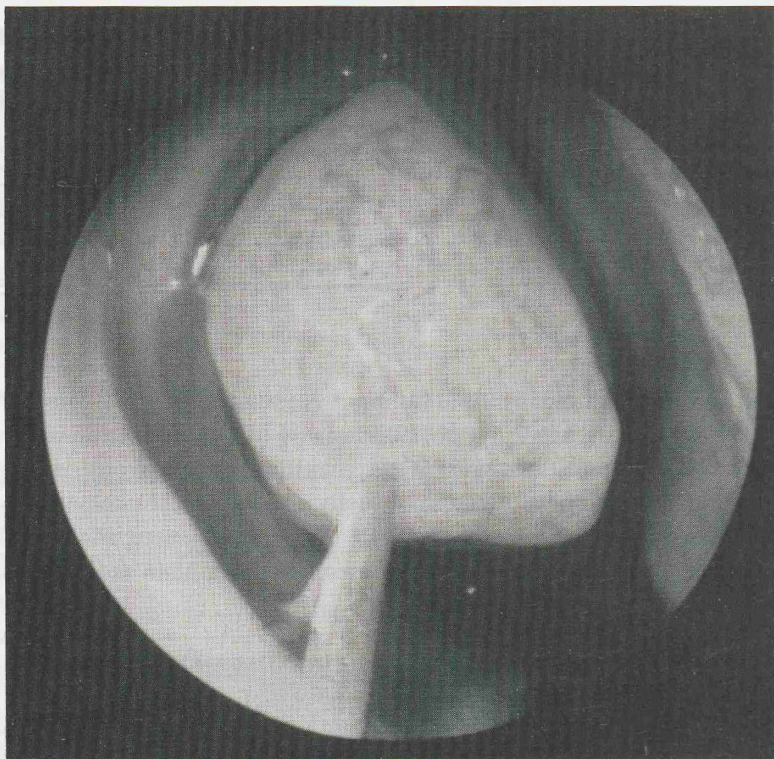


Figure 2 Concha bullosa; large, pneumatized middle turbinate of the right side, which bulged laterally and caused infundibular obstruction.

The amount of mucosal swelling of the ethmoid bulla correlated well with the radiological findings. Slight to moderate mucosal swelling was endoscopically found in 117 cases, and in 108 of these cases (92%) the radiographs showed slight or moderate cloudiness, or the ethmoid area was opaque. Intrabullar purulent secretion was found in 20 cases during FESS. In radiographs these cases showed slight or moderate cloudiness of the ethmoid area in 11 cases, in 9 cases the ethmoid cells were opaque.

DISCUSSION

Our material comprised of adult patients with chronic maxillary sinus disease, in whom active conservative treatment had already failed. Previous studies comparing plain radiographs and antroscopy have also dealt with children, patients with acute sinusitis and nasal polyposis, and tumours of the sinuses (Illum et al., 1972; Pfleiderer et al., 1986; Gilbert, 1989; Decreton and Clement, 1981). In this study we have paid special attention to the ethmoid area.

Antroscopy is capable of showing even the slightest amount of fluid retention. In this study it was considered to be the golden standard in the maxillary sinuses; in the ethmoid area the golden standard was endoscopic sinus surgery. Maxillary puncture and antral irrigation results have been used as a reference in sinus roentgenograms or ultrasound studies. These have shown both methods to be unable to predict the presence of fluid within the antra without error (McNeill, 1963; Pfeleiderer et al., 1984; Bertrand and Robillard, 1985). Also, negative antral irrigation is not always a reliable indicator of the absence of maxillary sinus secretion. As previously analyzed (Penttila et al., 1989 b), in this material 64% of the irrigation-negative antra showed mucoid or dry fungal secretion in antroscopy. Changes in frontal and sphenoid sinuses were detected by the radiologist, but since they were surgically entered only in a few patients no conclusions could be drawn concerning them.

Results in this study regarding the maxillary sinuses correlate well with previous studies. In the study by Illum et al. (1972) pathological changes of the antral mucosa were missed in 41 % of the cases in the X-ray examination. Pfeleiderer et al. (1986) found a negative correlation between antroscopy and plain radiographs in 55%, and in the study by Draf (1975) a discrepancy was found in 56% of the cases. In our patients, findings of plain radiographs and antroscopy concerning the antral mucosa were identical in half of the cases (53%) and in nearly half (43%) when looking for antral polyps (Figures 3a and 3b).

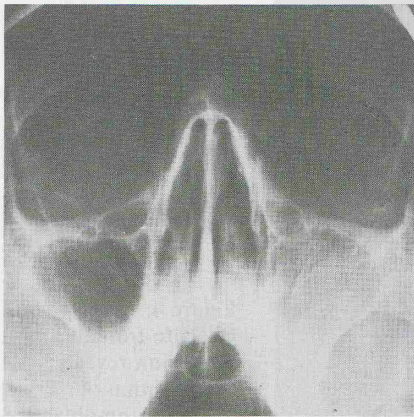


Figure 3a: Almost totally-opaque left maxillary sinus, which was thought to be secretion. During antroscopy a large polyp occluding the ostial area was found.

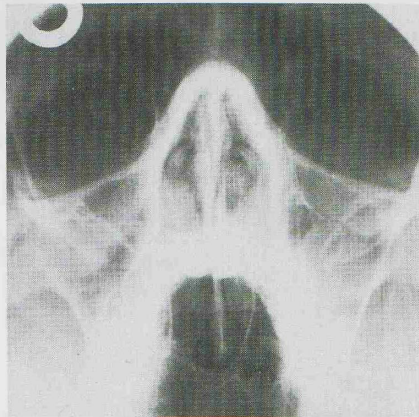


Figure 3b: Cloud-like antral roof opacifications bilaterally, correctly interpreted as polyps. No secretion was found during antroscopy.

Continuous retention of antral secretion is usually considered to be an important criterion of chronic maxillary sinusitis. Radiographic detection of antral fluid in patients with chronic sinusitis is difficult. In previous studies (Ollum et al., 1972; Pfleiderer et al., 1986; Gilbert, 1989) the rate of failure to detect fluid ranged from 38% to 62%. If the diagnosis is based only on a radiographic fluid level, our study failed to show the presence of antral fluid in 72% of the cases. In cases with radiographic mucosa! swelling the occurrence of antral secretion was remarkably high. Unlike maxillary irrigation, antroscopy is capable of showing small amounts of fluid retention, thickly organized glue and dry fungal material. These findings speak in favour for diagnostic antroscopy in patients with chronic maxillary sinusitis.

According to our knowledge no previous studies comparing plain radiographs of the ethmoid sinuses with FESS have been presented. The incorrect interpretation of radiological mucosa! pathology in the ethmoid area seems to be as frequent as in the maxillary sinuses. In Waters' projection the ethmoid sinuses are not clearly visible. For a better view an occipito-frontal projection is recommended (Figure 4). Small anatomical variations and slight pathological changes are hard to detect, but gross changes especially in the area of the ethmoid bulla

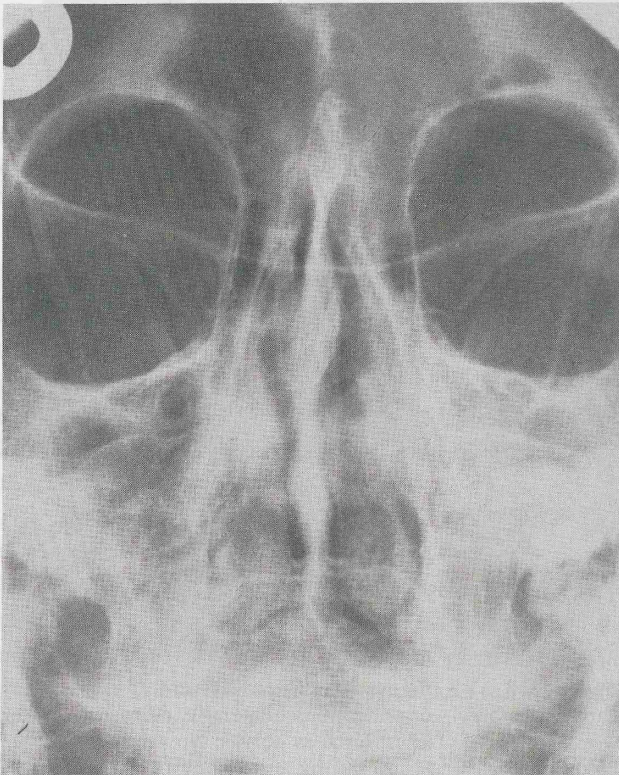


Figure 4
Occipito-frontal
projection reveals
opacification of
anterior ethmoidal
cells and left frontal
sinus. Waters'
projection did not
show these findings.

were seen quite reliably. The appearance of partial ethmoidal opacification can be caused by slight rotation, superimposed ethmoidal cells or anatomic variations. Considerable amounts of information can be obtained from these radiographs, if interpreted with care. Several factors cause difficulties in reading the sinus radiographs. Variations in the technical quality of the radiographs produce misinterpretations, i.e. underexposed over-reading and overexposed under-reading of the findings. Waters' projection alone is not effective enough in showing all changes in the sinuses, especially if the projection is overtilted. In an experimental study by Ohba et al. (1990), Waters' projection has been shown to be ineffective for detection of a globular, radiopaque mass placed on the anterior and posterior walls and the floor of the maxillary sinus. In our study we have found that polyps or cysts situated basally or laterally needed an occipito-frontal projection to be clearly visualized (Figures 5a and 5b). We have used the previously mentioned criteria to distinguish between antral cysts and antral polyps in the radiographs. But as Pollei and Harnsberger (1989) have pointed out, it usually is difficult to separate polyps from the surrounding mucoperiosteal swelling, and that cysts are better distinguished by the more sophisticated radiological methods.

The relative inexpensiveness and availability in practically all centers has been one of the reasons for plain radiographs serving as the principal screening method in patients with sinonasal complaints. The limited sensitivity of these radiographs with regard to lesions and anatomical variations in the area of the narrow ethmoidal clefts has led to the increased use of sinus CT, when available. Sinus CT detects minimal pathological changes in the sinonasal area and is recommended when FESS is under consideration (Stamberger, 1986).

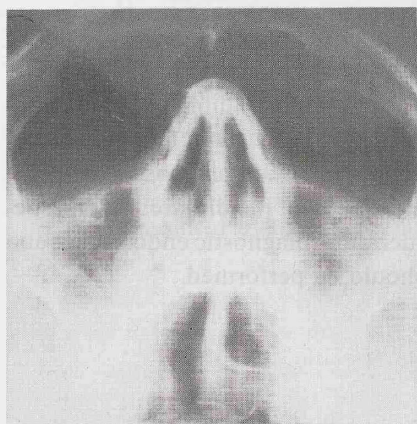


Figure 5a: Waters' projection radiograph was interpreted as showing slight thickening of the antral mucosa.

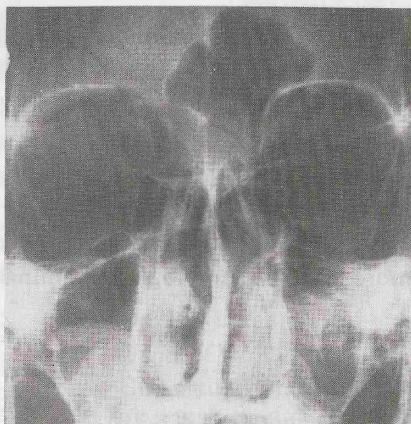
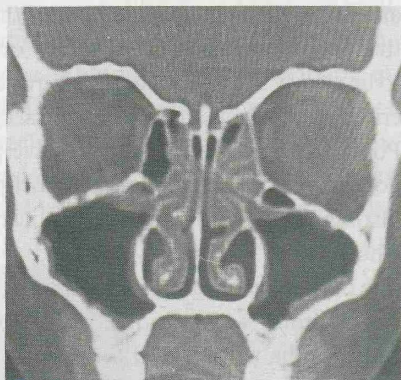
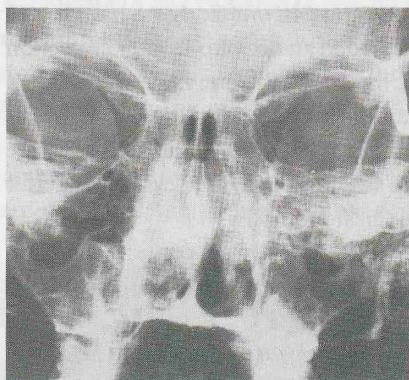


Figure 5b: Occipito-frontal projection of the same patient shows large retention cysts in maxillary sinuses at both sides.

Although sinus CT is accurate, Havas *et al.* (1988) discovered a remarkably high incidence of false-positive findings of paranasal sinus abnormalities in asymptomatic adults. In their study 42.5% of the patients showed paranasal sinus abnormalities, mainly mucosal thickening or anatomical anomalies. This result stresses the importance of meticulous correlation between radiologic and clinical findings before considering a diagnosis of chronic sinusitis or planning operative treatment. Sinus CT was not routinely used or analyzed in this study (Figures 6a and 6b).



Figures 6a and 6b: Occipito-frontal projection radiograph shows almost total ethmoidal clouding. It is confirmed in coronal CT-scan (Figure 6b).

CONCLUSIONS

Carefully-interpreted and technically-adequate plain radiographs taken in occipito-frontal, occipito-mental and lateral projections give valuable information in diagnosing sinus diseases. But since correlation of radiological and endoscopic findings is only well in patients with chronic sinusitis, repeated radiographic examinations of these patients seem to be quite unnecessary. Plain radiographs should be taken in the early stages of the disease. Later, especially if surgical procedures are under consideration, diagnostic endoscopies and more accurate radiological examinations should be performed.

REFERENCES

1. Bertrand BMG, Robillard TAJ. Comparative study of radiology, sinuscopy and sinus manometry in the maxillary sinus of the adult. *Rhinology* 1985; 23: 237-246.
2. Decreton SJ, Clement PA. Comparative study of standard X-ray of the maxillary sinus and sinuscopy in children. *Rhinology* 1981; 19: 156-159.
3. Draf W. Die Endoskopie der Nasennebenhöhlen: Diagnostische und therapeutische Möglichkeiten. *Laryngol Rhinol* 1975; 54: 200-215.
4. Gilbert JG. Antroscopy in maxillary sinus disease associated with nasal polyposis. *J Laryngol Otol* 1989; 103: 861-863.
5. Havas TE, Motbey JA, Gullane JP. Prevalence of incidental abnormalities on computed tomographic scans of the paranasal sinuses. *Arch Otolaryngol Head Neck Surg* 1988; 114: 856-859.
6. Ilium P, Jeppesen F, Langebaek E. X-ray examination and sinuscopy in maxillary sinus disease. *Acta Otolaryngol (Stockh)* 1972; 74: 287-292.
7. McNeil RA. Comparison of the findings on transillumination, X-ray and lavage of the maxillary sinus. *J Laryngol Otol* 1963; 77: 1009-1013.
8. Ohba T, Ogawa Y, Hiromatsu T, Shinohara Y. Experimental comparison of radiographic techniques in the detection of maxillary sinus disease. *Dent Maxil Facial Radiol* 1990; 19: 13-17.
9. Penttilä MA, Laranne JE, Pukander JS, Karma PH. Endoscopic or Caldwell-Luc approach in chronic maxillary sinusitis. Intraoperative and early postoperative comparisons. *Proc VIIth ISIAN International Symposium on Infection and Allergy of the Nose*, Baltimore, 11-15 June, 1989a.
10. Penttilä MA, Karma PH, Pukander JS. Clinical and endoscopic findings in chronic maxillary sinusitis. An analysis of 75 patients. *Proc XIVth World Congress of Otolaryngology-Head and Neck Surgery*, Madrid, 10-15 September, 1989b (in press).
11. Penttilä MA, Pukander JS, Karma PH. Endoscopic vs. Caldwell-Luc approach in chronic maxillary sinusitis. I. Comparison of the symptoms at one year follow-up. *Proc 13th Congress European Rhinologic Society*, London, 24-29 June, 1990a.
12. Penttilä MA, Pukander JS, Karma PH. Endoscopic vs. Caldwell-Luc approach in chronic maxillary sinusitis. II. Comparison of the findings at one year follow-up. *Proc 13th Congress European Rhinologic Society*, London, 24-29 June, 1990b.
13. Pfleiderer AG, Drake-Lee AB, Lowe D. Ultrasound of the sinuses: A worthwhile procedure? A comparison of ultrasound and radiography in predicting the findings of proof puncture on the maxillary sinuses. *Clin Otolaryngol* 1984; 9: 335-339.
14. Pfleiderer AG, Croft CB, Lloyd AS. Antroscopy: Its place in clinical practice. A comparison of antroscopic findings with radiographic appearances of the maxillary sinus. *Clin Otolaryngol* 1986; 11: 455-461.
15. Pollei S, Harnsberger HR. The radiologic evaluation of the sinonasal region. *Postgrad Radiol* 1989; 9: 242-266.
16. Stamberger H. Endoscopic endonasal surgery: Concepts in treatment of recurring rhinosinusitis. Part II. Surgical technique. *Otolaryngol Head Neck Surg* 1986; 94: 147-155.

Dr. J.E. Laranne
Dept. of Otolaryngology
University Central Hospital
SF-33520 Tampere
Finland

