

A-mode diagnostic ultrasound of maxillary sinuses: Possibilities and limitations*†

R. Mladina, R. Risavi, S. Branica, B. Heinzl

ENT Department, University Hospital Salata, Zagreb, Croatia

SUMMARY

The diagnostic possibilities and limitations of A-mode ultrasound of maxillary sinus diseases are presented. A group of 219 subjects suffering from various sinus diseases was examined. All cases were analyzed in parallel by means of X-rays, sinuscopy and ultrasonography. The investigated group was divided into seven subgroups, according to clinical entity (polypoid degeneration, polyps, cysts, et cetera). The comparison of the three techniques was made for each clinical entity. Some divergent findings that can be reached by these techniques were explained from the clinical point of view as well. The ultrasound A-mode technique plays a complementary role in the diagnostic process of maxillary sinus diseases. The main advantages of ultrasound technique are its harmlessness and non-invasivity.

Key words: ultrasound, A-mode, maxillary sinus

INTRODUCTION

Simple clinical examination in cases of suspected disease of the paranasal sinuses is not reliable per se. Radiography, however, was always considered to be much more reliable, but since sinuscopy was adopted in the early seventies as a very useful diagnostic tool in maxillary sinus diseases, it has become obvious that radiographic findings are not always in accordance with the sinuscopy picture. Frequently, pathologies such as excessive, soft polypoid mucosa! degeneration or simple mucosa! oedema were found in the patient's maxillary sinus, while at the same time X-rays showed mostly "normal" findings. On the other hand, many "positive" radiographic findings were found to be followed by a quite normal appearance of the mucosa and an appropriate volume of the maxillary sinuses during sinuscopy. These observations demonstrated the fact that much more attention must be paid in judging whether sinus disease exists or not, and if it does, in which form.

Fortunately, owing to the physical properties of ultrasound, it was possible to introduce it as a diagnostic tool in sinus diseases. It rapidly became clear that ultrasound is a harmless and non-invasive method which can, at the same time, give much more information about the inside of the maxillary sinuses than plain X-rays, and hence could in the great majority of cases eliminate the need for sinuscopy which has been considered as an invasive, although still harmless, technique.

On the other hand, everyday practice shows that ultrasound has its own limitations and because of that plays just a com-

plementary role in the diagnostic approach to maxillary sinus diseases. The aim of this study is to highlight the relationship between A-mode ultrasonographic, radiographic and sinuscopy findings in acute and chronic maxillary sinus inflammation as well as in other sinus diseases. Hence, this paper concerns the critical review of the diagnostic possibilities and limitations of A-mode ultrasound of maxillary sinuses.

MATERIAL AND METHODS

The investigated group consisted of 219 patients suffering from various sinus diseases: postnasal discharge (mucosa! hyperreactivity: 54/219), polypoid degeneration (32/219), polyposis (46/219), polypoid-cystic degeneration (13/219), cysts (30/219), empyema (37/219), and haematosinus (7/219).

Three usual techniques for maxillary sinus examination were used in parallel in each patient: plain X-rays, ultrasonography, and sinuscopy. Standard X-rays were taken in Water's projection under the standard radiologic performances.

Ultrasonography was carried out by means of Atmos Sectorscope HN using a 3.5-MHz transducer frequency under the maximal value of resolution, while gain and power values were around 3-4. The transducer was placed initially perpendicular to the canine fossa. Keeping its top at the same point on the face, the direction was changed through various angles until the signal on the screen was most visible and clear. The records were taken at this moment by freezing the picture. Owing to the specific nature of ultrasound - especially to the fact that the

* Received for publication May 6, 1993; accepted November 15, 1993

† Abbreviations: BWE: back-wall echo; IC: initial complex; OMC: ostiomeatal complex; pep: pleomorphic echo peaks; ps: "period of silence"; pw: "pillows"

wave can be transmitted through almost all media except air (Revonta et al., 1982) - the echogram of a healthy maxillary sinus shows only the initial complex, i.e. a graphic representation of how the wave spreads through the skin and subcutaneous tissue, anterior bony sinus wall as well as its internal mucosa lining. In our experience, the average length of the IC in healthy sinuses ranged from 5-8 mm. Because of that, all initial complexes that were longer than 8 mm were considered to be pathological.

In all cases sinoscopy was done through canine fossa approach in a standard manner and under local anaesthesia (2% xylocaine solution). Optics of 0°, 30° and 70° were used.

The period between examinations by different techniques was always very short, i.e. approximately 30 min (range: 5-45 min). Sinoscopy was always the last technique used.

RESULTS

Postnasal discharge/mucosa hyperreactivity

If the mucosa is thicker, the echogram is a little different from normal because the IC is wider and the actual finding would appear as in Figure 1. Figure 2 presents X-rays of the same sinus. The veil-like shade of both maxillary sinuses can be observed. Such findings were seen in 54 out of 219 patients, and the main symptom was postnasal discharge.

Polypoid degeneration

If the aetiological factors continue to act, the nature of the mucosa swelling will change from soft to a much more firm and solid form, progressing gradually towards the polypoid degeneration. Usually, X-rays still do not show any warning signs except observable marginal "pillows" which, unfortunately, are frequently ignored or minorized in a diagnostic as well as a therapeutical sense (Figure 3). The typical echogram shows an obviously distended IC (Figure 4) and usually has a lot of smaller echo peaks which could, probably, be the result of the various densities of the media through which the wave passes. This was seen in 32 out of 219 patients. The main symptoms were headache in 11 patients, nasal vasomotor obstruction in seven patients, postnasal discharge in five patients, and mixed symptoms in nine patients.

Sinus polyposis

Further progress of the pathological process causes more emphasized swelling of the previously mentioned "pillows" so that the sinoscopic finding shows almost polypous appearance of the sinus mucosa. The echogram becomes different too (Figure 5). The last echo appears at a depth of 21 mm while in the range between it and the IC another echo is visible, indicating that the densities of media through which the ultrasound wave passes are not equal. In this particular case the wave passes through the area of direct contact between the swollen, polypous mucosa of two neighbouring sinus walls. There is always enough mucus situated between them for the wave to be easily transmitted from one "coast" to another. If there were air between them, however, the wave would be interrupted. In addition, one must take into consideration the fact that a diseased sinus mucosa is

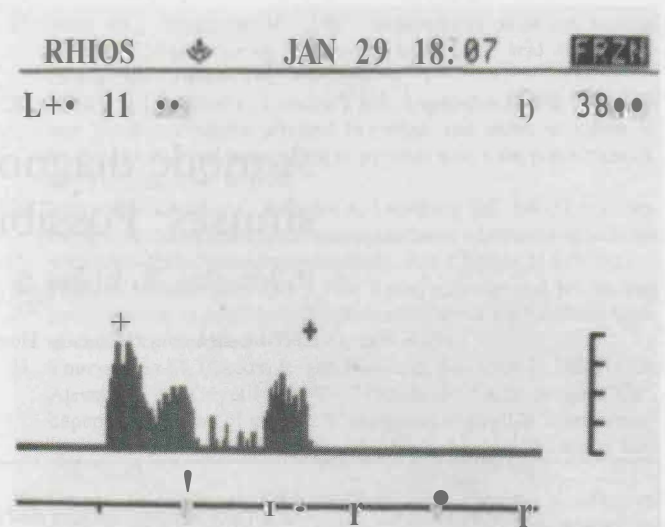


Figure 1 A very slight maxillary sinus mucosa thickening causing the echogram to deviate from its normal shape. The initial complex has been extended to 11 mm.

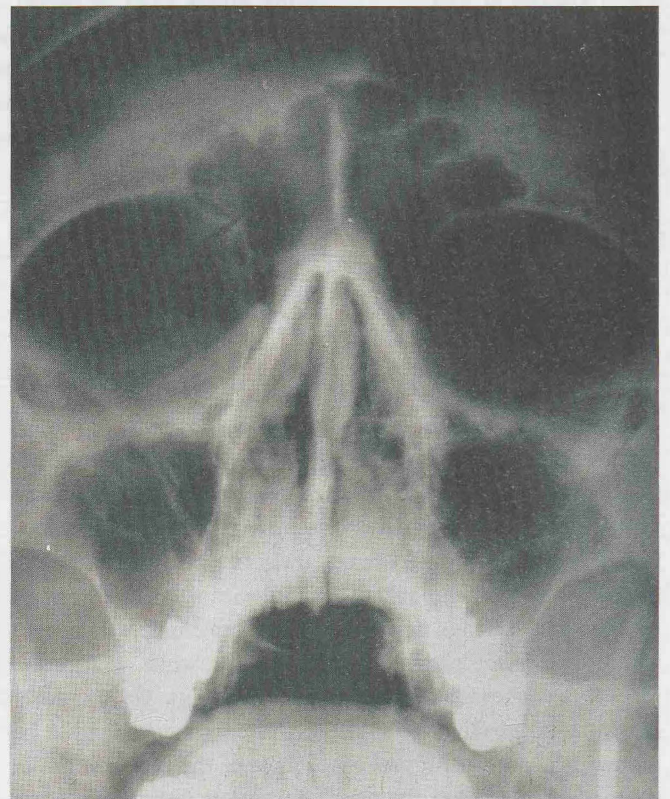


Figure 2 X-ray of the same sinus. The veil-like shade of both maxillary sinuses can be seen. This finding is usually described as "normal sinus transparency."

never equally swollen all over the sinus surface, especially at opposite walls. Sometimes the mucosa is quite sturdy owing to the prevalence of fibrous elements, and sometimes appears as soft oedema because of a high degree of intercellular liquid. This can cause some additional echo peaks of small amplitude. X-rays show polypoid changes in both maxillary sinuses. Such results were found in 46 out of 219 subjects. In 27 of them, rhinoscopic findings showed obvious polyps in the common nasal cavity, and in 19 cases the polyps were seen only under the

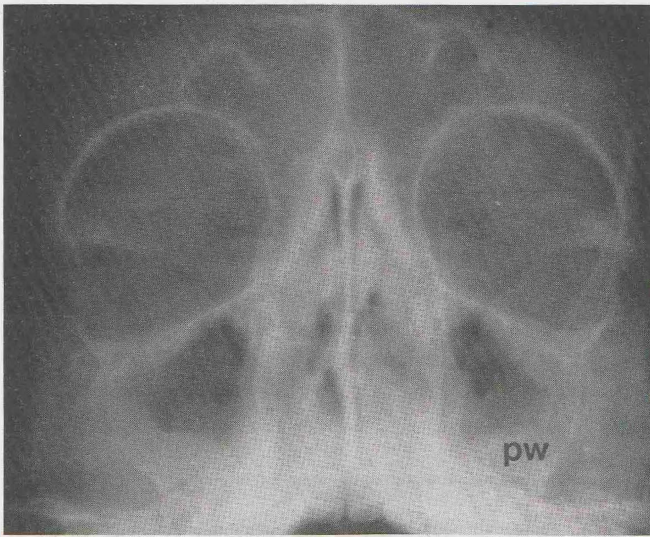


Figure 3. Polypoid degeneration. "Pillows" of thickened mucosa are easily seen (pw), particularly in the zygomatico-alveolar recess.

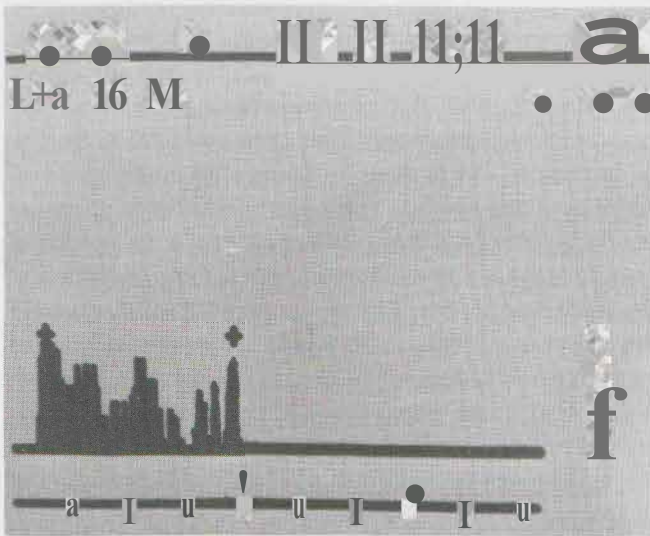


Figure 4. Echogram showing signs of polypoid degeneration of sinus mucosa thickening up to 16 mm.

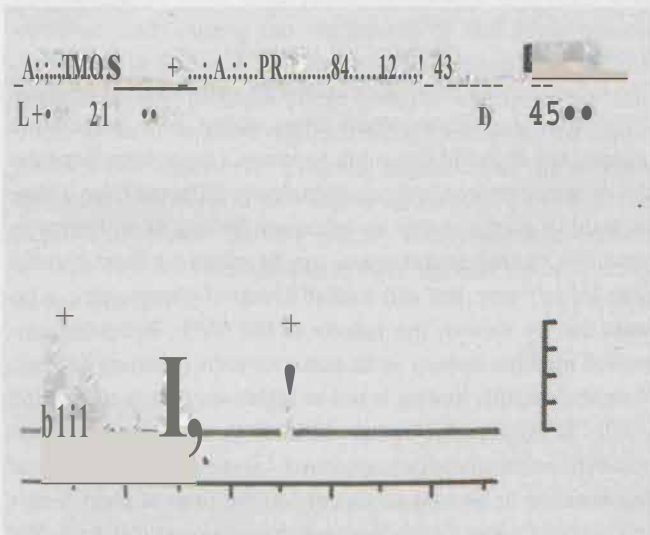


Figure 5. The deepest terminal echo is about 21 mm from the initial complex. Another echo peak is observable in between, indicating the boundary between two different soft tissues. This is a typical echogram of advanced polypoid degeneration (polyposis).

endoscopic visualization of the OMC. The main symptoms were headache in seven patients, nasal obstruction in 32 patients and both symptoms in seven patients.

Polypoid-cystic degeneration

Figure 6 presents X-rays of a patient suffering from advanced polypoid-cystic degeneration. A homogeneous bilateral shade does not necessarily indicate an empyema, however. It is proved by the echogram (Figure 7). Actually, it shows a pleomorphic picture, a "mess" indicating the contact of two different media, one of them being distinctly hypodense and the other hyperdense (cyst, polyp). Finally, sinuscopy confirmed both previous findings i.e. contact between a large cyst and huge polyp inside the maxillary sinus. Such a clinical picture was found in 13 out of 219 subjects. In seven of them rhinoscopic examination revealed vasomotor changes of the nasal mucosa. In four patients polypoid oedema of the OMC mucosa was seen and in two patients rhinoscopic findings were almost normal. The main symptom was nasal obstruction in nine patients, headache in three, and one patient reported mixed symptoms.

Cysts

A question of differential diagnosis between cysts and polyps arises. The echogram usually shows a simple, classical finding: a "period of silence" after the IC followed by a solitary echo at an average depth of about 25 mm (Figure 8). The wave spreads through the cyst backwards to the posterior wall frequently giving a double back-wall echo. It is doubled because of the

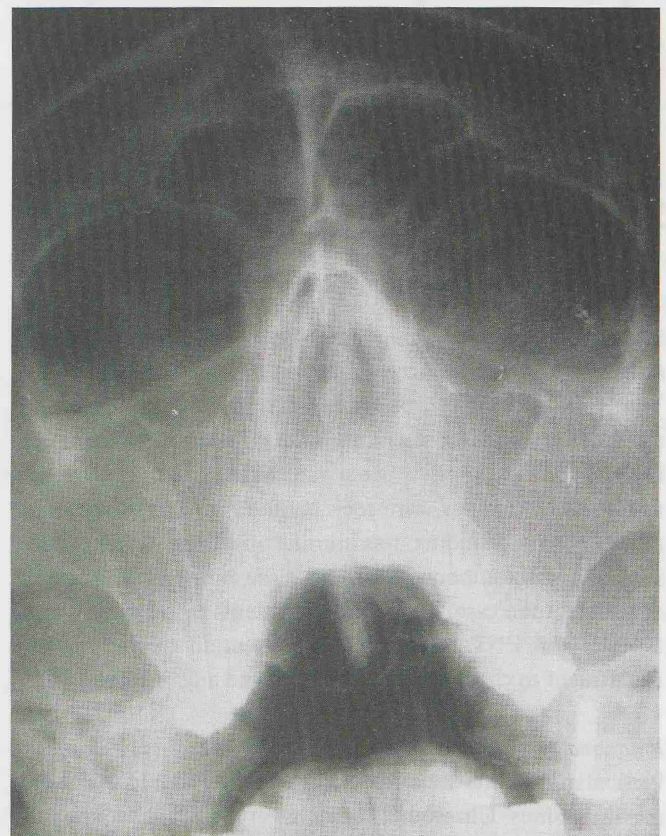


Figure 6. X-ray showing an intensive bilateral homogeneous shade of maxillary sinus.

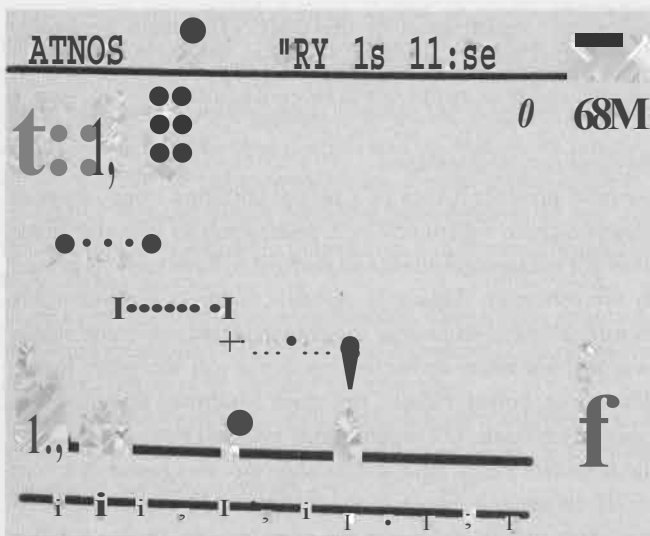


Figure 7. Terminal echo at a depth of 35 mm. Before this, at the level of 20 mm, a smaller echo is observable sometimes probably indicating contact between two media (and sometimes artefact), the first extending from the otherwise distended IC to a depth of 13 mm.

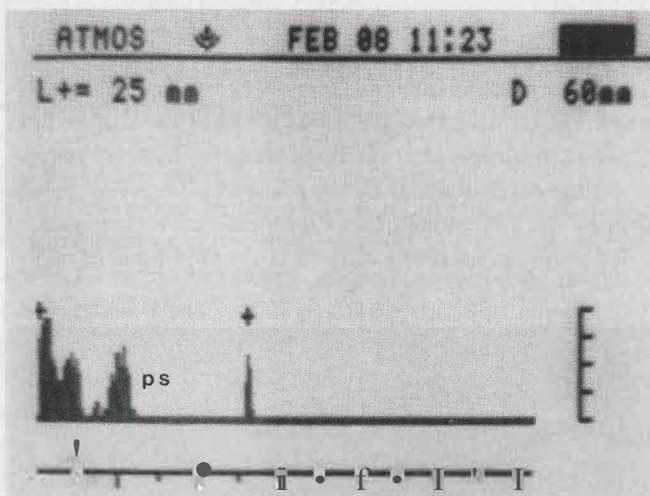


Figure 8. Typical echogram of solitary cyst with a characteristic "period of silence" (ps).

interaction of two different media in one point, i.e. the cyst membrane, and the mucosal lining of the posterior sinus wall. The typical finding can be seen only under the condition that the anterior sinus wall is in an intimate contact with the cyst itself. If contrary, the cyst is not visualized at all (false-negative result). Such findings were seen in 30 out of 219 subjects and the rhinoscopic finding was normal in all cases. The main symptom was a stubborn headache in the temporal (three cases) or parietal (one case) region. Some patients reported no symptoms in the ENT region, but were sent to our out-patient department to check whether there existed any focus or not.

Empyema

Particular attention must be paid to the free liquid inside the maxillary sinus. Ultrasound can help very much in the monitoring of treatment progress in acute maxillary sinusitis, especially in children and especially in cases with emphasized effusion

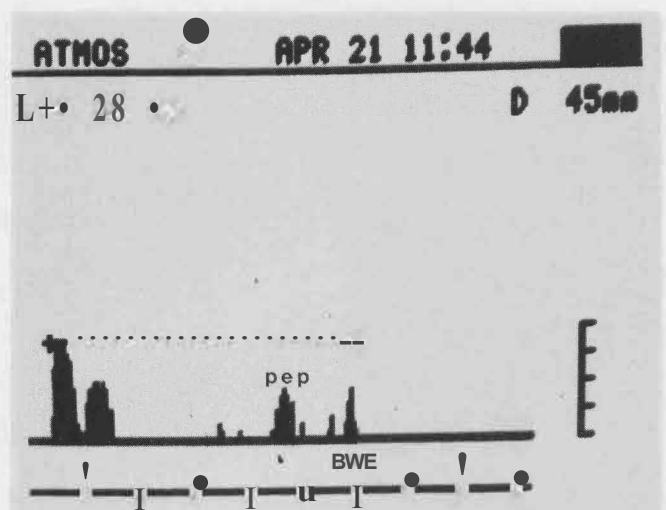


Figure 9. Echogram belonging to haematosinus. A small group of pleomorphic echo peaks (pep) can be seen in the vicinity of the BWE.

where progress is undoubtedly connected with diminution of the amount of liquid and, therefore, can be easily checked up (Revonta et al., 1982). But, an echogram presenting a large solitary cyst and one presenting an empyema are quite similar. The distinction can only be made by means of a so-called shift test. The aim of this test is to check wave permanence in various positions of the head, particularly in extension. In the case of empyema, the pus level will always be horizontal, regardless of the actual head position. That is why the BWE will disappear in the extension position: an amount of air will be interpolated between the anterior sinus wall and the pus. On the other hand, in the case of a large solitary cyst, BWE is permanent, regardless of the actual head position.

We found a positive shift test in 37 out of 219 patients. The rhinoscopic finding revealed pus in the common nasal cavity in 23 of them, and in 14 patients pus was found only in the OMC. The main symptoms were fatigue, weakness, painful percussion of the cheek and headache.

Haematosinus

The same test can be applied also at an early stage of haematosinus; after a relatively short time, owing to a coagulation process, the blood in the sinus becomes a huge homogeneous clot of semi-firm consistency, completely different from a simple fluid. Figure 9 shows an echogram belonging to haematosinus. No significant difference can be noted between it and a large solitary cyst, but still a small group of pleomorphic echo peaks can be seen in the vicinity of the BWE, indicating emphysematous medium density in its posterior parts (contrary to cyst). Nevertheless, this finding is not as highly specific as to become a rule. It is, actually, rather difficult to make a distinction between acute sinusitis, empyema, cystic-polypoid mucosa! degeneration or haematosinus only on the basis of plain X-rays and without good quality and reliable anamnestic data. We saw seven patients with haematosinus. Four of them were injured in traffic accidents, two in fist fighting, and one was injured at work.

DISCUSSION

With respect to the diagnostic possibilities of A-mode ultrasound of maxillary sinuses it must be pointed out that errors regarding technique of examination procedure itself, as well as the manner of interpretation are equally possible and could, therefore, limit the usefulness of the method as a whole. According to Mann et al. (1977), the reliability in diagnosing normal air-containing sinus, mucosa! thickening and discharge ranges up to 90%. Revonta (1979) pointed out that the reliability of diagnosing discharge in the maxillary sinuses in children even exceeds 97%. But the differentiation between mucosa! thickening and mucosa! plug is often very difficult in air-containing sinuses using a simple A-mode (Mann et al., 1977). Hence, one has to be careful and cautious so as to avoid mistakes and disorientation in the diagnostic process. On the other hand, one has to keep in mind the fact that ultrasonography of the maxillary sinuses is a complementary method in the diagnostic process of sinonasal pathology, and has no absolute value in distinguishing between various pathological processes (Mann et al., 1977; Risavi et al., 1990).

Anyway, the use of ultrasound is plausible in cases such as solitary cysts or polyps, which are not always distinguishable or clear on the basis of clinical examination or plain X-rays or even CT scanning. After all, the treatments of these two entities differ diametrically from each other and, therefore, it is of great importance to make a distinction between them. In these cases ultrasound helps very much in avoiding an unnecessary ionization caused by CT-scanning of paranasal sinuses. However, if the cyst or polyp is not in contact with the anterior sinus wall, the ultrasound finding could be false negative. This is obviously one of the most important limitations of the ultrasound of maxillary sinuses.

In cases of excessive postnasal discharge plain X-rays and even CT scans are commonly described as normal, but thorough analysis still reveals the presence of a veil-like shade of both maxillary sinuses. This is one of the points where ultrasound can help, as in these cases it usually shows a distended initial complex emphasizing the thickening of the sinus mucosa. According to Revonta (personal communication), in a Finnish population the thickness of the anterior wall from the transducer to the air-mucosa interface is 10 ± 2 mm when the sinus is healthy. Our experience, however, suggests that the length of the initial complex is in the range from 5-8 mm. This thickening is probably caused by very gracile, watery mucosa! oedema, which in fact does not necessarily have any serious influence on its transparency.

On the other hand, even CT scans in such cases sometimes show false-negative results. It was noticed that they were not always reflected accurately during surgery, so that the disease was seen to be far more extended than that shown on CT (Kaluskar et al., 1993).

Regardless of that, CT scanning still remains the most reliable and appropriate technique in evaluating the chronic inflammation of the maxillary sinus, especially because of the fact that chronic maxillary sinus diseases are most frequently caused by inflammation of the ethmoidal sinuses or patho-anatomical circumstances of the ostiomeatal complex.

On the other hand, the greatest advantage of ultrasound use is its harmlessness. One is able to follow up sinusitis and the progress of treatment by means of daily ultrasound examinations.

Ultrasound is undoubtedly a diagnostic tool of great value in giving a quick orientation and making a distinction between various entities. It can help in particular cases to make a decision on whether to use more precise diagnostic procedures: a slightly uncomfortable sinuscopy, on one hand, or relatively expensive (and harmful because of radiation) CT scanning on the other.

ACKNOWLEDGEMENT

The authors cordially thank Dr. Matti Revonta from the ENT Department of Hameenlinna (Finland) for his precious suggestions.

REFERENCES

1. Mann W, Beck C, Apostolidis T (1977). Liability of ultrasound in maxillary sinus diseases. *Arch Otorhinolaryngol* 215: 67-74.
2. Revonta M (1979) A-mode ultrasound of maxillary sinusitis in children. *Lancet* 10: 320.
3. Revonta M, Suonpaa J, Luukkala M, Merlainen P (1982) Diagnostic ultrasound of maxillary and frontal sinusitis. A new simple echoscope and method. *Acta Otolaryngol (Stockh) Suppl* 386: 265-267.
4. Risavi R, Mladina R, Subaric M, Markov D, Pis! Z (1990) A comparison of sinusoscopic, radiographic and ultrasonographic findings in the diagnosis of maxillary sinus diseases. *Radio! Yugosl* 24: 347-351.
5. Kaluskar SK, Patil NP, Sharkey AN (1993) The role of CT in functional endoscopic sinus surgery. *Rhinology* 31: 49-52.

R. Mladina, MD
ENT Department
University Hospital Salata
41000 Zagreb
Croatia