Comparison Between A-Mode Ultrasonography And Radiography In The Diagnosis Of Maxillary Sinus Diseases

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✓ A-mode ultrasound examination of the maxillary sinus was compared with radiological examination in 387 subjects suggestive of paranasal sinus diseases to detect sensitivity, specificity and confidence of the ultrasonography in the diagnosis of the maxillary sinus diseases. Ultrasound tracings were obtained with Atmos model ultrasound and the records were interpreted by the same two authors. Waters' view radiography was performed on all patients. The patients were classified according to their age. In the adult group: ultrasonography had an overall sensitivity of 68%, specificity of 93% and confidence of 85% in the detection of secretion; sensitivity of 95%, specificity of 92% and confidence of 93% in the detection of mucosal thickening; sensitivity of 66%, specificity of 86% and confidence of 84% in the detection of cystic lesion of the maxillary sinus. In the children group: ultrasonography had an overall sensitivity of 92%, specificity of 3% and confidence of 93% in the detection of secretion; sensitivity of 95%, specificity of 94% and confidence of 95% in the detection of mucosal thickening, sensitivity of 50%, specificity of 97%, confidence of 95% in the detection of cystic lesion of the maxillary sinus. When compared with surgical findings, Waters' view radiography and ultrasonography of the maxillary sinus, A-mode ultrasonography with a sensitivity of 94% seemed to be a reliable diagnostic method in the diagnosis of maxillary sinus diseases and it also gave useful information in the follow up course of the therapy of paranasal sinus diseases.

Ky Words: A-mode ultrasonography, Radiography, Maxillary sinus disease.

✓ Maksiller Sinüs Hastalıklarının Tanısında A-Mod Ultrason ve Radiografinin Karşılaştırılması

Paranasal sinus hastalığı şüphesi olan 387 kişiye, maksiller sinüs hastalığını tanımlayan ultrasonografinin duyarlılık, özgürülük ve güvenilirliğini test etmek amacıyla maksiller sinüsünün A-mod ultrason muayene radyojenik muayene ile karşılaştırıldı. Ultrason traceleri Atmos model ultrason ile elde edildi ve kayıtlar aynı tipteki otur taraflarından yorumlandı. Bütün hastalarda Waters grafleri çektilerdi. Hastaların yaşlarına göre sınıflandırıldı. Erişkin grupta; ultrasonun maksiller sinüsü sekresyon tespitinde %68 duyarlılık, %93 özgürülük ve %85 güvenilirliği; mukoza kalmalı tespitinde %95 duyarlılık, %92 özgürülük ve %93 güvenilirliği; kısıtlı lezyonların tespitinde %66 duyarlılık, %86 özgürülük ve %84 güvenilirlik vardı. Çocuk grubunda; ultrasonun maksiller sinüsü sekresyon tespitinde %92 duyarlılık, %93 özgürülük ve %93 güvenilirliği; mukoza kalmalı tespitinde %50 duyarlılık, %97 özgürülük ve %95 güvenilirliği vardı. Maksiller sinüsünün ameliyat bulguları Waters radiografisi ve ultrasonografi ile karşılaştırıldığında, A-mod ultrasonografi %94 duyarlılık ile maksiller sinüs hastalığının tanısında güvenilir bir tanı yöntemi olarak görülmektedir ve paranasal sinüs hastalıklarının tedavi ve takibi carrying bilgiler sağlamaktadır.

Anahtar Kelimeler: A- mod ultrason, Radiografi, Maksiller sinüs hastalık.

Paranasal sinus disease is one of the most important disease affecting the population. The symptoms and signs of the disease mimic other upper respiratory tract infectious diseases. Therefore some difficulties can be faced in the diagnosis of the pa-
ranasal sinus diseases. A positive bacterial culture from aspirated sinus secretion is the most reliable method. This is an invasive method and requires cannulation the sinus to aspirate secretion. Noninvasive techniques such as transillumination, radiography and ultrasonography can also be used as a diagnostic method[1,2,3].

Radiography is the most frequently used method for confirming the diagnosis of sinusitis. In general, four standart projections are used in the examination of paranasal sinuses. However Water's view radiography is the most popular technique. The radiographic findings are the presence of an air-fluid level, complete opacification, mucosal thickening or dome shaped mucocel. Radiographic mucous membrane thickening is a source of confusion. The greater the thickening of the mucous membrane, the more likely the presence of fluid[2].

A-mode ultrasound is a simple, painless, noninvasive method and does not expose the patient to ionizing radiation. The diagnostic use of ultrasound energy is based on the reflection of pulsed ultrasound energy from the tissue boundaries of different acoustic nature. These reflections generate an electric current that is amplified and displayed on an oscilloscope screen. Ultrasound applied over the maxillary sinus results in various peaks on the screen, corresponding to patterns of soft tissue, bone, fluid air in focus[4,5].

There are many reports in the literature about the use of A-mode ultrasound examination in the diagnosis of sinusitis. Recent reports provide different opinions. Some authors report good results[6] and the others report disappointing results[7,8]. The concordance of ultrasonography and irrigation in maxillary sinusitis is reported to be 80% to 97% in adults and 94% in children[4,10].

The aim of this study is to establish the correlation between A-mode ultrasonic examination and radiography of paranasal sinus and to detect the sensitivity, specificity, and confidence of the ultrasonography in the diagnosis of paranasal sinus disease.

Materials and Methods

This study consisted of 387 patients with suspected paranasal sinusitis. Clinical examination, Water's view and ultrasonography were performed on the first visit. Ultrasonography was performed immediately after clinical examination and Waters' view radiography was performed within 2 hours of clinical examination. Caldwell-Luc operation was performed on 33 cases within 2 or 3 days after clinical examination and ultrasonography.

The patients were classified into 2 different groups.


Radiographic findings were classified as follows:

Mucosal thickening (3 to 6 mm or > 6mm), cystic shadow, a horizontal fluid meniscus in the sinus, or complete opacity.

Ultrasonography was performed on all patients using an A-mode ultrasonography*. The frequency of the probe was 3.5 MHz and the diameter was 10 mm. The patient sat in an otologic examination chair. This transducer was placed on the anterior wall of the sinus beneath the orbital margin and the sinus was examined. A good acoustical contact between the transducer and skin was secured with contact jelly.

* ATMOS Medizintechnik GmbH H
The image on the oscilloscope screen was freeze-dried to obtain hard copies that were retained for interpretation.

The findings were retained for interpretation:

1) Normal echogram: Front wall echo < 1.5 cm.

2) Mucosal thickening: Front wall echo 1.5 to 3 cm.

3) Sinus fluid: Back wall echo 4 to 6 cm from maxillary sinus front wall or 2 to 3 cm from frontal sinus front wall.

4) Polyp or cyst: Double echo 4 to 6 cm from maxillary sinus front wall or 2 to 3 cm from frontal sinus front wall.

Ultrasound results were interpreted by one of two authors who was blinded to the Waters’ view radiography results.

Sensitivity was calculated by dividing the number of positive ultrasound by the number of positive X-ray findings. Specificity was calculated by dividing the number of negative ultrasounds by the number of negative X-ray findings. Confidence was detected by dividing the sum of real positive ultrasounds and real negative ultrasounds to the sum of real positive X-rays and real negative X-rays.

**Results**

The results were investigated on 2 different groups. In the adult group sensitivity, specificity and confidence of the detection of secretion, mucosal thickening and cyst of the maxillary sinus were assessed separately (Table 1). The sensitivity was 83% and the specificity was 94% and confidence was 87% for all subjects in the adult group. The ultrasound was positive for secretion in 127 of the 186 X-rays, for mucosal thickening in 288 of the 304 X-rays, for cyst in 42 of the 64 X-rays. The agreement between the A-mode ultrasound and X-ray was higher in the detection of the mucosal thickening than others.

In the children group; sensitivity, specificity and confidence of the detection of secretion, mucosal thickening and cyst of the maxillary sinus were assessed (Table 2). The ultrasound was positive for secretion in 68 of the 74 X-rays, for mucosal thickening in 82 of the 86 X-rays, for cyst in 4 of 8 X-rays.

Thirty three maxillary sinuses with suspected sinusitis using Water’s view radiography were explored and the findings were compared to X-rays and ultrasonography. In this group, pathological evaluation was available for 31 cases with the ultrasonographic examination. It has been assessed pathological findings in 31 of all 33 cases with the operation. According to the operation results; sensitivity, specificity and confidence of the ultrasound were 94%, 0% and 88% respectively (Table 3).

In the present study the total obliteration was a sign of secretion according to our and some authors’ results[11], because of agreement between operation results of the total opacity showed cases and ultrasound and X-rays in 100% of the cases.

**Discussion**

Two basic types of ultrasonography are available for clinical use. A-mode ultrasonography is produced by a single sound beam that produces a linear display on the viewing monitor. In the B-mode ultrasonography, the probe emits multiple sound beams and the echoes are displayed in a two-dimensional cross-sectional image. In almost all ultrasound studies of the paranasal sinuses the A-mode has been used and its results were compared to the other diagnostic methods such as radiography of paranasal sinus, puncture and transillumination. However, Gianoli et al., compared the
Table-1: Sensitivity, specificity and confidence of the A-mode ultrasound compared to the radiography in the maxillary sinus group (582 maxillary sinuses).

<table>
<thead>
<tr>
<th>Secretion</th>
<th>Mucosal thickening</th>
<th>Cyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>%</td>
<td>No</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>127/186</td>
<td>63</td>
</tr>
<tr>
<td>Specificity</td>
<td>370/396</td>
<td>93</td>
</tr>
<tr>
<td>Confidence</td>
<td>497/582</td>
<td>85</td>
</tr>
</tbody>
</table>

Table-2: Sensitivity, specificity and confidence of the A-mode ultrasound compared to the radiography in the pediatric maxillary sinus group (192 maxillary sinuses).

<table>
<thead>
<tr>
<th>Secretion</th>
<th>Mucosal thickening</th>
<th>Cyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>%</td>
<td>No</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>68/74</td>
<td>92</td>
</tr>
<tr>
<td>Specificity</td>
<td>110/118</td>
<td>93</td>
</tr>
<tr>
<td>Confidence</td>
<td>178/192</td>
<td>93</td>
</tr>
</tbody>
</table>

Table-3: Comparison of the radiography, ultrasonography and operation findings in the maxillary sinus (33 cases).

<table>
<thead>
<tr>
<th>Operative group</th>
<th>Ultrasonography</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>Positive</td>
<td>31</td>
</tr>
<tr>
<td>Negative</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
</tr>
</tbody>
</table>

Sensitivity : 29/31 = 94%
Specificity : 0/2 = 0%
Confidence : 29/33 = 88%
B mode ultrasonography with computed tomography findings and reported that sensitivity and specificity of the ultrasonography were 100% and 98% respectively. Mann et al., in 1977, correlated the sonographic findings with the results of irrigation, X-rays, sinuscopy and sinomanometry and found it correct in 90% of the cases. Recently Revonta and Suopaa reported agreement between puncture and sonography. Previous correlations between X-rays and maxillary aspiration have demonstrated as 83% to 100% presence of secretion when X-ray demonstrates near total opacification or air-fluid levels.

Landman, compared A-mode ultrasonography of the maxillary sinus with X-ray, clinical finding, irrigation or pathology. He found the sensitivity and specificity for ultrasound 100% and 99% respectively. In another study, A-mode ultrasonography was found significantly more reliable than X-ray. Revonta and Kuuliala studied the use of A-mode ultrasonography and Waters' view radiography in the diagnosis and follow-up eighteen children with acute maxillary sinusitis using clinical findings as the control. Concordance of ultrasonography and radiography was 91% on day 1, declined to 76% by day 20. Concordance with clinical findings on day 20 were 71% for radiography and 93% for ultrasonography. The authors concluded that ultrasonography reflects a return to normal sooner than radiography.

There can be false negative and positive findings in the ultrasound studies of the paranasal sinuses. False negative findings can be due to small amount of discharge, poor acoustical contact and technical failure of radiographic examination. False positive findings may be due to multiple reflections from the bone and air boundaries or the transducer may be directed towards the orbit, laterally to the zygoma or to the mandible. It is of importance to examine the whole area of the sinuses in different directions and special care must be directed towards the bottom of the sinus in order to detect small amounts of secretion.

The diagnostic value of ultrasonography in cases showing antral opacities in plain X-rays has been recognised by other workers, such as Berg and Carenfell; Edell and Isaacson found A-mode ultrasound most beneficial in differentiating opacification of the maxillary sinus radiographs due to technical or anatomopathologic condition. Axelson et al. reported total radiographic opacity as a sign of secretion in 86% of cases, while Revonta found corresponding figures of 85% in adults and 75% in children.

Mann et al. and Mann compared A-mode ultrasonography with an occipitofrontal projection in the diagnosis of the infant and adult sinusitis, but no trephine findings were reported. They found the absence of the bone wall echo in all of the radiographically normal sinuses and corresponding to 86% of the sinuses with a radiographic mucosal thickening in the adult group. It was also reported that radiographically normal 192 frontal sinuses were also normal in a scan. A correlation between normal and abnormal findings of the two methods was detected in 67.5% of the infant group. Revonta found the confidence of A-mode ultrasonography in children 96%.

These results agree with the results of the present study. In the adult group the confidence of A-mode ultrasonography has been found to be in 85%, 93% and 84% of the subjects in the detection of secretion, mucosal thickening and cyst respectively.
Especially there was the greatest success in the detection of the mucosal thickening of the maxillary sinus than the others. In the children group, the confidence of A-mode ultrasonography were 93%, 95% and 95% in the detection of secretion, mucosal thickening and cyst respectively. There was greater success in the detection of all pathological findings in the children group than in the adult group. In the operation group radiography and the ultrasound showed equal capability of seperating diseases from non diseased sinuses. However the ultrasound was able to correctly detect different pathological conditions in 100% compared to 88% (29/33) cases with radiography in the same group.

The advantages of the diagnostic ultrasound are being noninvasive method without any known deleterious biological effect, rapid, painless, inexpensive and easily reproducible[19]. A-mode ultrasound examination is quite reliable method for the determination of pathological conditions within the maxillary sinus. These pathological conditions require therapy and follow-up. The A-mode ultrasound examinations can also be used to follow the response to treatment without x-ray exposure and it is a useful adjunct to the physical examination in the diagnosis and follow-up at sinusitis.

Conclusions

A-mode ultrasound is a rapid and safe screening test for maxillary sinusitis. Ultrasonography is particularly helpful in the children group and more informative in these situations being able to differentiate with greater accuracy between thickened mucosa, polyp or cyst and fluid. Ultrasonography seems to be a useful adjunct to the physical examination in the diagnosis and follow-up of sinusitis.

REFERENCES
