

# The pulsed ultrasound method adapted for examination of paranasal sinuses

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## SUMMARY

*Three different ultrasonic display systems for examination of paranasal sinuses (oscilloscope; light emitting diodes; gas discharge display) have been evaluated in model experiments, on healthy subjects and in clinical materials. With the three different ultrasonic display systems air could be separated from other types of sinus contents in model experiments. The detectable amount of saline solution in normal sinuses was 1-5 ml with all display units. The different display units showed the same screening capacity as radiography. The oscilloscope display system was significantly more efficient than the other display systems in separating different pathological conditions. Also regarding radiography the oscilloscope display was significantly more efficient in detecting secretion, but no difference was found in the capacity of predicting intrasinus cysts. Thus, the oscilloscope display seems to be the most useful for both clinical and scientific purposes.*

There is few commercially available equipment satisfying the needs for screening of paranasal sinuses with suspected sinusitis. Therefore, three different pieces of ultrasonic equipment adapted for screening purposes have been tested in experiments on plexiglass- and bone sinus models as well as on healthy human sinuses. After the experimental test the three pieces of equipment were used in a clinical material consisting of 100 patients (138 maxillary and 10 frontal sinuses). The results of the ultrasonic examination were compared with those of radiography, and also checked invasively by sinus lavage, sinuscopy or frontal sinus trepanation.

## EQUIPMENT

Generally, an ultrasonic apparatus consists of a transmitter, a receiver and a display unit. In the present study three different display units - oscilloscope (OSC), light emitting diodes (LED), and gas discharge (GD) display - have been tested and evaluated (Figure 1). A newly designed receiver with a quasi-logarithmic am-

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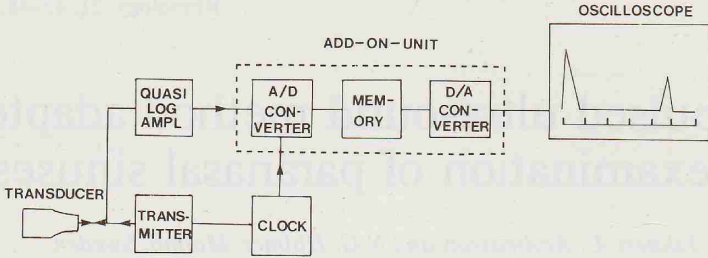


Figure 1a. Block diagram of the equipment using an oscilloscope as the display unit.

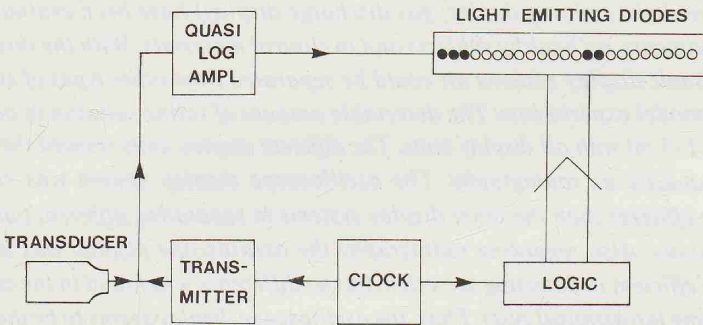


Figure 1b. Block diagram of the equipment with a single row of light emitting diodes as the display unit.

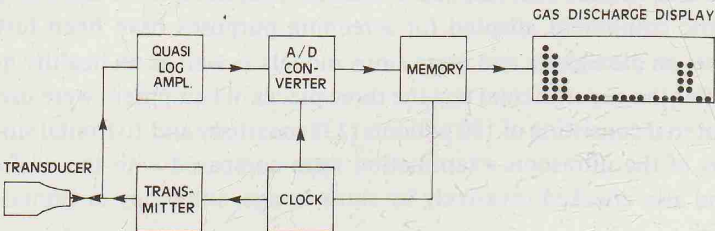


Figure 1c. Block diagram of the equipment with a gas discharge display.

plifier was used in all display units. The properties of this device are such that weaker signals are amplified more than stronger ones, thus allowing echoes with widely varying intensities to be simultaneously displayed. This means that the equipment gives an improved display and is easier to handle than other available apparatus.

### RESULTS OF THE EXPERIMENTAL TESTS

Air was separated from other types of content in the sinus models and penetration of up to 16 mm bone was recorded on all display units. Artificial mucosal swelling ( $\leq 3$  mm), fluid and cyst-like objects were separated from each other with the OSC-display. Artificial mucosal swelling  $< 8$  mm could not be detected with the LED- and GD-displays, and these two display units could not differentiate between saline solution or cyst-like objects. A statistically significant difference was found in the amount of saline solution detectable in a human sinus with the OSC (mean 1.6 ml, range 1–3 ml) compared with the GD-display (mean 2.1 ml, range 1–5 ml), and the LED-display (mean 3.1 ml, range 1–5 ml). Artificial cysts in human sinuses were detected with the OSC-display but not with the other display units.

### RESULTS OF THE CLINICAL MATERIAL

With the OSC-display, 97% of the sinuses were correctly judged as normal or pathological. The corresponding figures for the LED- and GD-displays were 90% and 93%, respectively. The screening capacity of the radiological examination in separating a diseased sinus from a healthy one was 95%. Thus, no statistically significant difference was found in the screening capacity of the different display units and the radiological examination.

When separating different pathological conditions, the OSC-display was significantly more efficient than the LED- and GD-displays. Secretion was correctly diagnosed with the OSC-display in 26/34 sinuses compared with 11/34 with the radiological examination performed in three standard projections. Cysts were correctly indicated in 25/35 sinuses with the OSC-display and in 23/35 sinuses with the radiological examination. In cases showing total opacity at the radiological examination the sinus content was correctly diagnosed in 19/23 cases by using the OSC-display. The corresponding figure for both the LED- and GD-displays was 15/23. In cases with frontal sinusitis the different display units and radiography showed a 90% agreement with the findings at the trepanation.

### CONCLUSIONS

The different display units tested showed a screening capacity comparable to radiological sinusal examination. The OSC-display was statistically significantly better than the other display units and radiography in separating different pathological conditions within the sinusal cavities.

### ZUSAMMENFASSUNG

Drei verschiedene Systeme der Ultraschallanzeige bei Nebenhöhlenuntersuchungen (Oszilloskop, Lichtemittierende Dioden, Gasentladungsanzeige) sind miteinander verglichen worden und zwar in Modellexperimenten, an gesun-

den Versuchspersonen und an klinischen Fällen. Mit allen drei Anzeigesystemen konnte in Modellexperimenten Luft von anderen Nebenhöhleninhalten unterschieden werden. Die nachweisbare Menge Kochsalzlösung in normalen Nebenhöhlen betrug 1-5 ml bei allen Anzeigeformen. Alle drei wiesen auch die gleiche Screeningkapazität wie die Röntgenuntersuchung auf. Die oszillografische Anzeige war gegenüber den beiden anderen Anzeigemethoden signifikant besser dazu geeignet, verschiedene pathologische Zustände zu unterscheiden. Für den Nachweis von Sekret war die oszillografische Anzeige auch der Röntgenuntersuchung signifikant überlegen während für den Nachweis von Sinuszysten kein Unterschied vorlag. Somit erscheint die oszillografische Anzeige als am besten für sowohl klinische als auch wissenschaftliche Zwecke geeignet.

#### REFERENCES

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