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Ultrasonography of the paranasal sinuses. A new computerized equipment using LCD-display and Capture mode

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SUMMARY

Ultrasonography of the paranasal sinuses is a well established method. However, no technical development in this field has taken place during the last five years. In order to improve the method a new computerized equipment with a graphic liquid crystal display (LCD) and capture mode has been designed.

INTRODUCTION

Ultrasonography of the paranasal sinuses has during the last ten years been proved to be a valuable method in diagnosing sinusitis. The method is now accepted biy the regional social insurance office in The Netherlands, West Germany, Norway, Sweden, and Finland. The method is safe, rapid and has a diagnostic accuracy of about 90–95%. (Mann et al., 1977; Revonta, 1980; Jannert et al., 1982).

All previous pieces of equipment have included a cathode ray tube (CRT) as the display unit. In order to improve the method, a new computerized equipment with a graphic liquid crystal display (LCD) has been constructed with the following aims:

1. to obtain reliable indication even on small abnormalities;
2. to create a handy format of the instrument;
3. to make the display easily readable even in daylight;
4. to provide all information on the display;
5. to handle the echograms from the different sinuses in a way minimizing the risk of mixing;
6. to make it possible to store the echograms either on paper or in a computer file;
7. to provide electrical safety to the patient and examiner.

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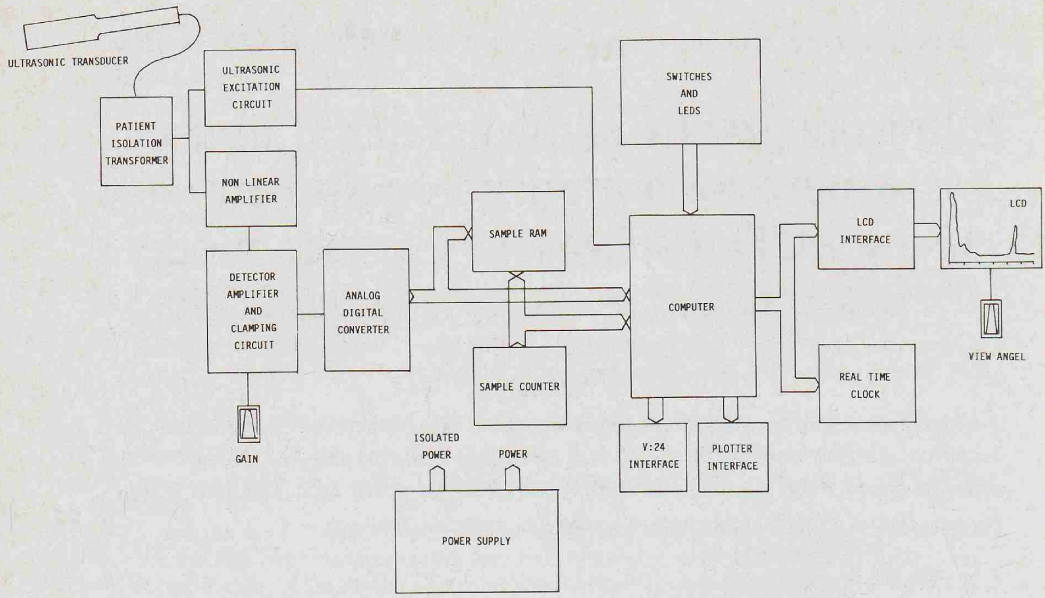

Figure 1. Block diagram of the computerized equipment.

TECHNICAL SOLUTIONS

To realize these aims in a fairly compact instrument, a computer is used to control all timing and data transfer to the display and to the external units (computer, plotter). The principal design is seen in Figure 1.

Patient safety: The PATIENT ISOLATION TRANSFORMER ensures a galvanic isolation of the patient from the instrument.

Excitation of ultrasonic crystal: The computer generates pulses to the ULTRASONIC EXCITATION CIRCUIT. This circuit excitates the ULTRASONIC TRANSDUCER to transmit ultrasonic sound waves.

Amplifier: A completely new method which combines high resolution in the near field with superior penetration is used. In order to separate echoes from the frontal wall of the sinus from other echoes, a low intensity of the transmitted sound wave is used for the near field part of the echogram, while higher intensities (still below 10 mW/sqcm) are used to create the echogram from more distal parts of the sinus.

Echo processing and digitizing: The reflected sound waves in the tissue boundaries of the patient are converted by the ULTRASONIC TRANSDUCER to an electrical signal. This signal is fed through the PATIENT ISOLATION TRANSFORMER, amplifiers and signal processing units to the ANALOG-DIGITAL CONVERTER. The digitized data are stored in the SAMPLE RAM.

The computer: The COMPUTER fetches the data from the SAMPLE RAM and

arranges them to be displayed by the Liquid Crystal Display, LCD, via the LCD INTERFACE. The operator can easily control the transmission of data via a push button. The information can be fed either to a PERSONAL COMPUTER via the V:24 INTERFACE (filing) or to the plotter via the PLOTTER INTERFACE. The REAL TIME CLOCK is read from the computer and used at documentation.
Documentation: Four pictures, one for each sinus can be stored in the instrument during examination (Figure 2).
Quick screening - Capture mode: With this improvement the most prominent echoes at each depth received during the entire examination are captured and stored on the display. Thus, when examination is concluded all echoes appearing during the examination are kept on the display until they are erased.

DISCUSSION

In most pieces of equipment for ultrasonography of the paranasal sinuses the

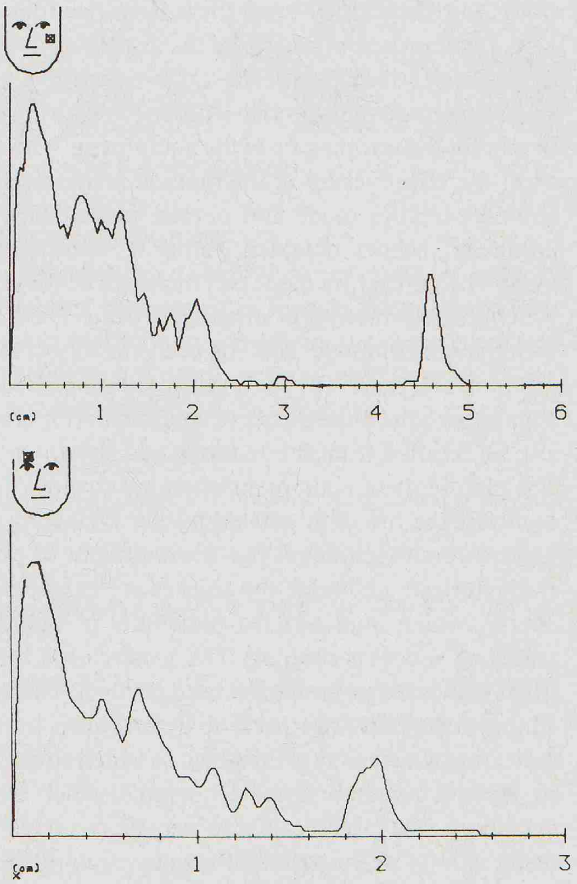

Figure 2.
Example of a registration of a maxillary and frontal sinusitis.

echoes are displayed on an oscilloscope (CRT). Other systems using light emitting diods (LED) (Revonta, 1980; Jannert et al., 1982) or gasdischarge display (GD) (Jannert et al., 1982) have also been tested. Compared to the oscilloscope both the LED and the GD-display have a poorer resolution and nowadays only pieces of equipment with LED are commercially available. The LED equipment furthermore needs to be used in a darkened room as the LED signals are intensity modulated. The resolution of the LED equipment is poor as every LED corresponding to a distance of 5 mm compared to the resolution of the oscilloscope which is only 0.3 mm.

There is no possibility of documentation available with the LED equipment. The CRT equipment can be documented either with polaroid photo or by a printer, of which the latter is most convenient.

With the use of a LCD (Sinus 320, Teltec AB, Sweden; Figure 3) the resolution (0.3 mm) is equivalent with the CRT-display. By exchanging the CRT to a LCD it is possible to reduce the size of the equipment considerably. The LCD can be used in bright day light and there is no need for darkening of the room. If the equipment is used in poor light the display can be illuminated with electroluminescent (EL) back light. The LCD is working as soon as the main power is switched on and there is no loss of time as with the CRT where the examiner have to wait for the warming up of the equipment. With the computerized LCD equipment the effectiveness of the method is increased as the examiner can choose between capture mode and normal mode. With the capture mode the most prominent echoes obtained during a scanning manoeuvre are stored in the memory. The capture mode can therefore be looked upon as a screening method which reduces the risk of missing an echo. The final examination is performed with the normal mode, and due to the facility of storing four pictures during the examination, there will be no risk for mixing up the different sinuses which may happen with the older pieces of equipment (Figure 3). The stored echograms can also be recalled from the memory and shown on the display at any time.

The old pieces of equipment often use manual time-gain compensation which increases the risk of unreliable results. Detecting of mucosal swelling only with hitherto used techniques has been difficult or even impossible. With the new computerized technique the sinuses are examined with four different levels of energy, which improves the possibility of examining the anterior sinus wall regarding mucosal swelling. The plotter used for documentation is rapid and silent compared to the earlier used printers. The document, (Figure 2), presents all four echograms together with depth scales, time of examination and symbols indicating which picture is related to which sinus. The symbols of the examined sinuses are coloured as the echograms, which facilitates the readability of the document. The plotter can, if so wanted, be connected and used with a tympanometer as well as the actual ultrasonic equipment.

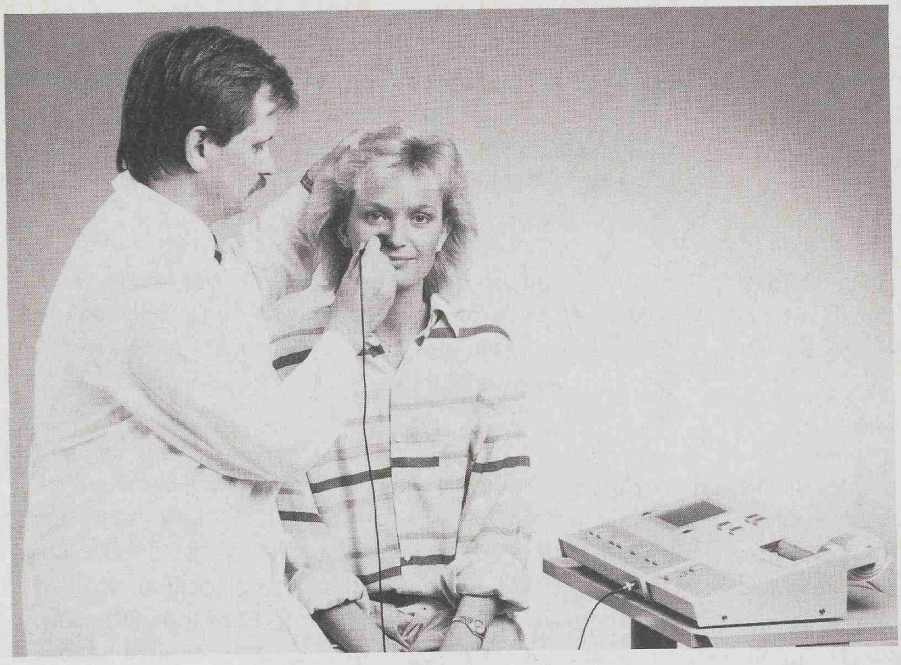

Figure 3. Examination of a patient using the new equipment.

ZUSAMMENFASSUNG

Ultraschalluntersuchung der Nebenhöhlen der Nase ist eine anerkannte Methode. In den letzten fünf Jahren, aber, wenig technische Entwicklung ist in diesem Gebiet geschehen. Um die Methode zu verbessern, eine neue computerbasierte Ausrüstung mit LCD-(flüssiger Kristall)-Schirm und "Capture Mode" (Echo-Ackumulation) ist konstruiert worden.

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