Ultrasonic Diagnosis in General Surgery

A FIRST REPORT FROM THE JOHANNESBURG GENERAL HOSPITAL

E. G. GOUDIE, J. B. MYERS, J. E. MORLEY

SUMMARY

The value of ultrasound as a diagnostic aid in a variety of surgical conditions is discussed. Particular mention is made of its use in distinguishing between solid and cystic lesions. It is a non-invasive investigation of increasing importance in the assessment of aortic aneurysms.

S. Afr. Med. J., **48**, 203 (1974).

Ultrasound first gained prominence during World War II, when, known as sonar, it was used by ocean vessels for locating submarines. About 20 years ago it became utilised as a non-invasive investigation in obstetrics and gynaecology, and recently its use has gained recognition as a useful diagnostic aid in a variety of surgical conditions.

Ultrasonic diagnosis is based on the reflection of sound waves of high frequency and low intensity from boundaries which occur between different tissues in the body. The change in characteristic impedance at each tissue border causes a fraction of the ultrasonic energy to be reflected. Those reflected echoes which return at a right angle to the transmitter are then picked up by the signal receiver and converted into electrical energy. This signal is then amplified and displayed on a screen. Energy not reflected in this way travels further and is available to produce echoes from other interfaces.

Gas almost completely reflects the ultrasonic waves, thus imposing serious limitations to investigation of gas-containing structures such as bowel and lung. At the other extreme, bone absorbs the ultrasound waves very rapidly, and targets behind bone are not within reach of the beam. Soft tissues have characteristic impedances which vary between these extremes and can therefore be delineated and defined.

There are two major types of diagnostic ultrasound, viz. Doppler and sonar. Doppler is based on the fact that a shift in frequency occurs when a continuous beam of ultrasound is reflected from a moving structure. It is used to detect foetal heart beats, arterial blood flow and deep vein thrombosis. Sonar depends on the varying impedance of different structures and the echoes returning from these targets. The results are displayed in one of two ways—A mode or B mode.

Department of Radiology, Johannesburg General Hospital, Johannesburg
E. G. GOUDIE, M.B. B.CH
J. B. MYERS, B.SC., M.B. B.CH.
J. E. MORLEY, M.B. B.CH.

Date received: 21 August 1973.

An A scan screen shows a time position picture. It is one-dimensional. The transducer is held still in one position. A beam of ultrasound is sent in a straight line through the underlying structures. From each interface an echo is returned, and if it is returned at a right angle it is received. This echo is amplified and displayed as a peak or spike along a base line. Each peak denotes an echo from an interface. The machine is carefully calibrated so that the time and distance are related on the display. A very accurate assessment of the size of a structure and its distance from the surface can be read off from a graduated scale. This measurement is often marked by a set of markers on the screen. Variations in height of echo can be used to determine the type of tissue structure.

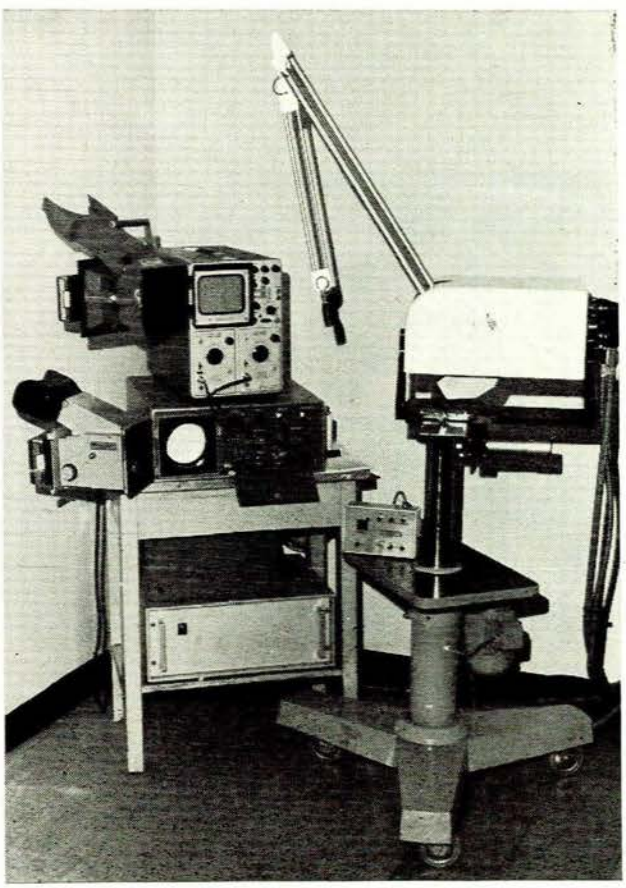

Fig. 1. The Ekoline 20 Diagnostic Ultrasonoscope used in this study.

The B scan display is two-dimensional. The probe is passed across the skin—remaining in contact with the skin all the time. Each echo received is displayed on the screen as a dot. Using the storage oscilloscope, in this case a Tektronics storage oscilloscope, these dots are stored and a composite picture is built up. Depth of penetration is 35 cm and allowance is made for the attenuation of distant signals so that a uniform picture is achieved.

The equipment used was an Ekoline 20 Diagnostic Ultrasonoscope, the frequency 1 - 3 MHz, the transducer operating at 2,25 MHz and the intensity was in milliwatts. Polaroid cameras were used to photograph the results (Fig. 1).

MATERIALS AND METHODS

Liver and Gall Bladder

In surgery one of the major uses of sonar has been in the investigation of the liver. The outline of the liver can easily be shown in longitudinal and transverse scans. A clear delineation of cystic lesions of the liver, which appear as echo-free transonic areas on the cathode ray tube, can be obtained. Confirmation of hepatosplenomegaly can be made (Fig. 2). Cirrhosis of the liver produces an increase in the echo content of the liver.[1] Ultrasound is useful in the detection of solid masses in the liver, but differentiation between types of solid mass is difficult.[2]

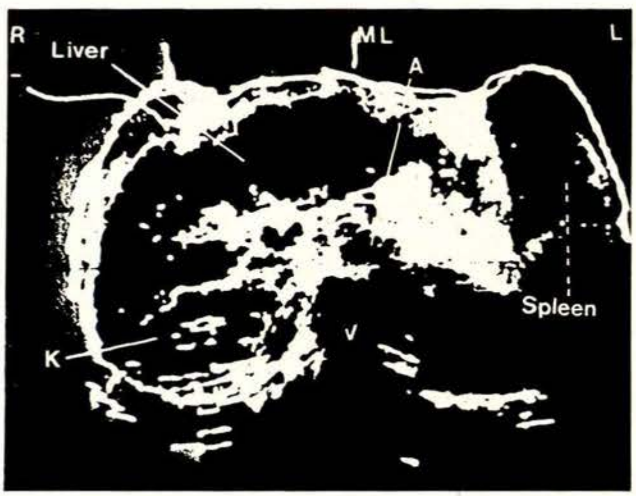

Fig. 2. Transverse scan showing liver and grossly enlarged spleen.

Enlarged gall bladders can be clearly distinguished and calculi can be demonstrated within the gall bladder.

Ascites of volumes as small as 150 ml can be found.[3] Major ascites produces a bizarre picture where the bowel either floats freely towards the midline (Fig. 3), or is seen to be tied down by adhesions.

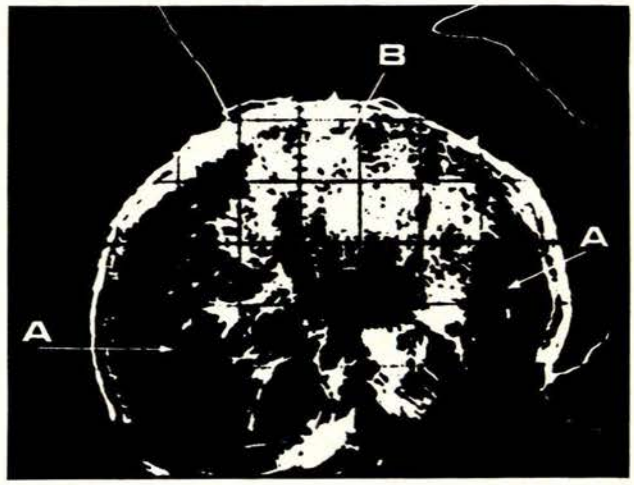

Fig. 3. Transverse scan showing ascites with bowel (B) floating freely towards the midline.

Abdominal Aortic Aneurysm

Ultrasound is a useful technique in measuring the size of aortic aneurysms. The size of the aneurysm can be accurately determined and the presence of thrombus can be detected. The thrombus does not mask the size of the vessel as happens in aortography.

Aneurysmal involvement of the common iliac artery, external iliac artery and femoral artery can be seen more readily on the right side than on the left, and it has been found a worthwhile procedure to scan these areas in every patient with abdominal aortic aneurysm.

As this investigation requires no preparation it can be done on outpatients. An example of ultrasonography of aortic aneurysms is shown in Fig. 4.

Fig. 4. Transverse scan showing aortic aneurysm with thrombus formation.

Neck Tumours

Ultrasound has been found useful in the differentiation of solid and cystic thyroid structures.[4] It is, however, only of additional and supplementary importance and does not replace the commonly-used thyroid diagnostic methods.

Renal Tumours

Changes in the size and shape of the kidneys can be shown on the B scan (Fig. 5). Besides being used to show renal cysts and tumours, it can also be used to assess some major renal anomalies such as agenesis, hypoplasia and ectopic kidney.[5] It can also be used to outline transplanted kidneys, and by making use of serial measurements Leopold[6] has suggested that it may be of use in detecting early rejection by showing persistent enlargement of the kidney.

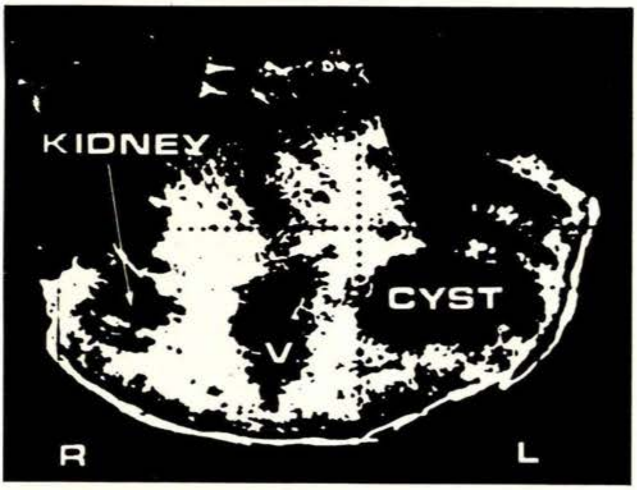

Fig. 5. Transverse scan showing cystic tumour in left kidney.

Breasts

Jellins *et al.*[7] from Sydney, have used ultrasound to show breast cysts, fibro-adenosis, fibro-adenoma and carcinoma with or without skin attachment.

DISCUSSION

Ultrasonic diagnosis has proved to be a useful additional diagnostic aid in a variety of surgical conditions. It is particularly useful in distinguishing between cystic and solid tumours in the abdomen, thyroid and breast. In determining the size and shape of aortic aneurysms it has the distinct advantage of being a non-invasive technique, which often gives information equal to aortography. In the acute situation where there is guarding and rigidity, the advantage of having access to sonar is obvious. The presence of free fluid, or of a tumour, or abscess cavity, can usually be determined, and the structure and size defined. The use of sonar is equally important in cases where there is an ill-defined tumour or there is conflict of opinion in regard to the size, nature or even presence of a tumour.

All cases reported in this article were under the care of Mr J. Lannon, and we thank him.

REFERENCES

1. Wells, P. N. T., McCarthy, C. F., Ross, F. G. M. and Read, A. E. A. (1969): Brit. J. Radiol., **42**, 818.
2. Holm, M. M. (1971): *Ibid.*, **44**, 24.
3. McCarthy, C. F., Wells, P. N. T., Ross, F. G. M. and Read, A. E. A. (1969): Gut, **10**, 904.
4. Thijs, L. G. (1971): J. Clin. Endocr., **32**, 709.
5. Barnett, E. and Morley, P. (1972): Hosp. Med., **8**, 531.
6. Leopold, G. R. (1970): Radiology, **95**, 687.
7. Jellins, J., Kossof, G., Buddee, F. W. and Reeve, T. S. (1971): Med. J. Aust., **1**, 305.