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ULTRASOUND – A NEW IMAGING TECHNIQUE.

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INTRODUCTION

Ultrasound, or high frequency sound beyond that of human hearing range, has been used for obstetrics work for the past decade or so. Although 20 kilohertz and above is considered to be in the ultrasound range, medical ultrasound uses frequencies of 0.5 to 20 megahertz. For abdominal ultrasound, a frequency of 2.5 megahertz is generally used.

Ultrasound is produced by mechanical vibrations of a piezo-electric material. This is housed in a transducer probe and the same transducer acts as a receiver, since the property of a piezo-electric material is reversible i.e. when a voltage is applied on opposite surfaces, the material changes shape and when mechanical forces are applied a voltage is produced.

The ultrasound produced is made to pass through the body and at every boundary it encounters, it is made to reflect back into the transducer probe from where the current produced is amplified and fed into a computer which reconstructs images either in the form of amplitudes, bright spots or a tomographic image of the area scanned. These are respectively called the A, B and compound B scans or modes. Further analysis by the computer converts the compound B into various shades of grey and this is called the grey-scale image.

Modification of the A mode with a moving baseline gives the M-mode which is used to detect foetal heart movements and to differentiate between blood vessels from other tubular structures.

In using ultrasound for imaging, the pulse-echo technique is employed, where the transducer produces the ultrasound in pulses and in the latent period, acts as the receiver of returning echoes. This is opposed to the Doppler technique employed to measure blood flow which uses two probes, one continuously producing ultrasound and the other acting as the receiver. The construction of the ultrasound unit is such that an organ can be scanned in various planes. As such, almost any abdominal and pelvic organ can be accessible.

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LOCAL EXPERIENCE

At present the Universiti Kebangsaan Malaysia has one ultrasound unit, the Diasonograph 4200 as shown in Fig. I. My experience over the past year involved mainly scanning areas of the liver, pancreas, kidneys, abdominal masses including aneurysms of the abdominal aorta, choledochal cysts and pancreatic cysts.

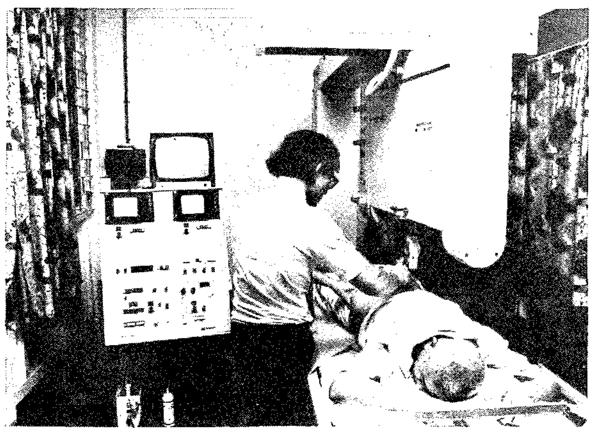

Fig. 1
The author operating the Diasonograph 4200.

Most of the examinations of the liver involved jaundiced patients. Ultrasound examination is one of the most useful non-invasive examinations in cases of jaundice. In obstructive jaundice, dilated hepatic ducts are easily shown and careful scanning may even show the site, and at times the nature, of obstruction. High obstruction of the common bile duct may be due to enlarged glands at the porta hepatis or cholangiocarcinoma. Low duct obstruction may be caused by carcinoma of the head of pancreas (Fig. 2) or acute pancreatitis (Fig. 3). Obstruction due to calculus may be detected.

The next investigation following an ultrasound examination which has shown dilated biliary ducts would be a transhepatic cholangiogram, preferably using the Okuda needle. This may show the site of the obstruction and the nature, and hence, the cause, of obstruction may be made more obvious. Fig. 4 shows obstruction of the common bile duct due to calculus at the lower end.

Apart from this, hepatomas, secondary deposits and liver abscesses may be demonstrated. Fig. 5 shows two abscesses in the right lobe.

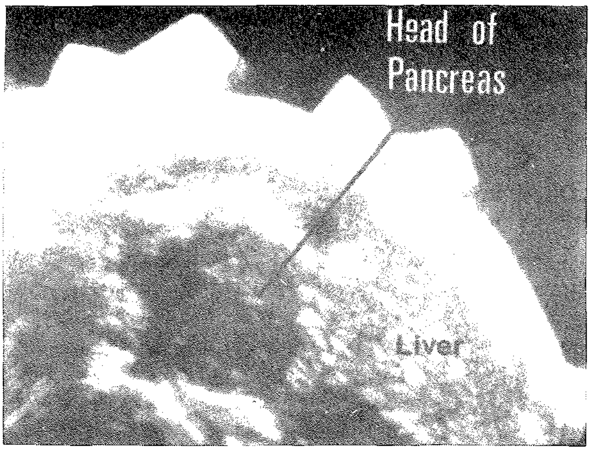

Fig. 2
Transverse section showing a large carcinoma of the head of pancreas.

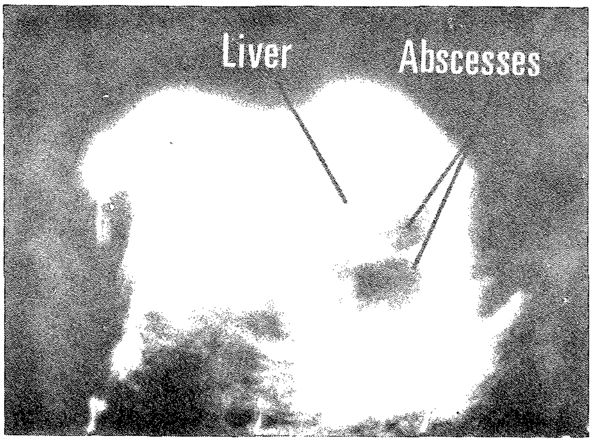

Fig. 3
Transverse section showing high density echoes around the pancreas due to chronic pancreatitis.

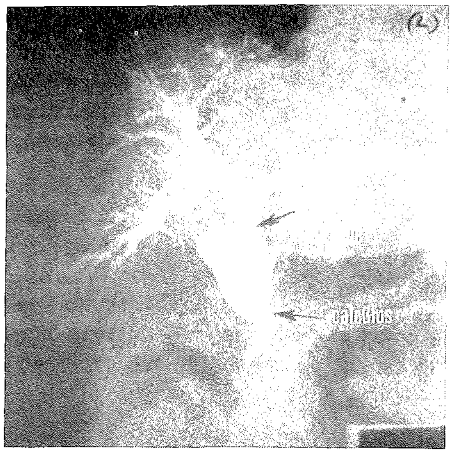

Fig. 4
Dilated biliary ducts and gallbladder due to a stone in the common bile duct, demonstrated by percutaneous transhepatic cholangiogram.

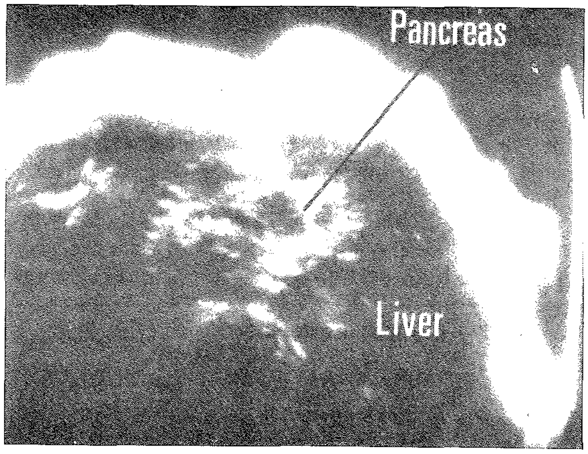

Fig. 5
Transverse section showing two liver abscesses in the right lobe.

The presence of a gallstone can be shown by high level echoes in the gallbladder, along with an acoustic shadow beyond, as shown in Fig. 6.

Renal ultrasound generally follows an intravenous urogram examination which may show a non-functioning kidney or a mass lesion. The most useful information obtained from an ultrasound examination is its ability to distinguish a solid from a cystic lesion. Cystic lesions are generally benign and at some centres cyst punctures are done at the same sitting as the ultrasound examination. Solid renal masses are generally malignant, as shown in Fig. 7. Hydronephrotic kidneys and secondary deposits in the kidney can also be picked up on ultrasound.

The pancreas has always been a difficult organ to image before the era of ultrasound. Isotope scans

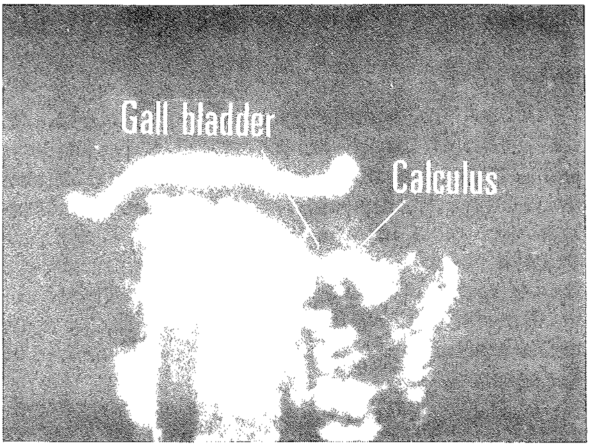

Fig. 6
Longitudinal section showing a stone in the gall-bladder. Note the acoustic shadow cast by the stone distally.

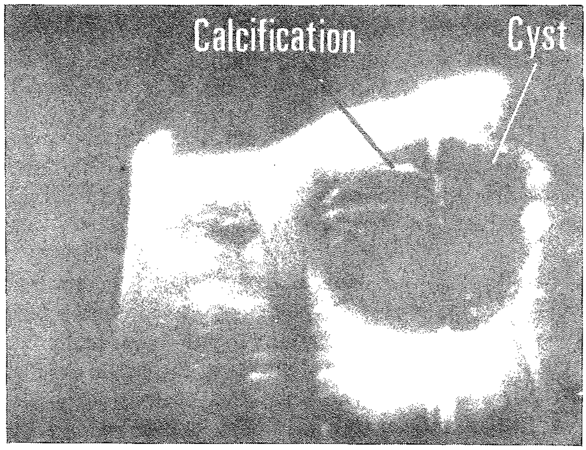

Fig. 8
Prone logitudinal section showing a large tumour with areas of calcification within it. At operation, this proved to be a dermoid cyst adherent to the tail of pancreas.

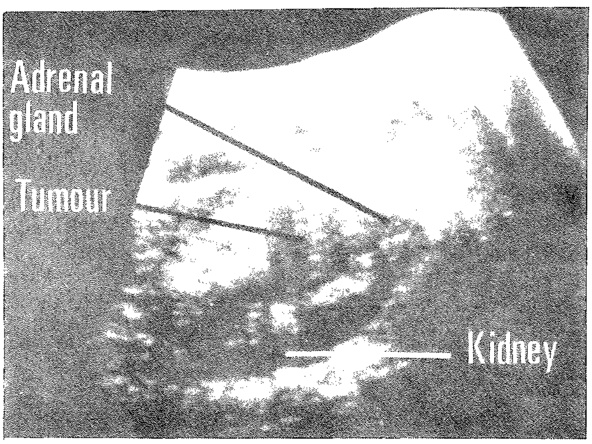

Fig. 7
Prone Longitudinal section of the right kidney showing a large tumour in the upper pole posteriorly. Note the normal adrenal gland.

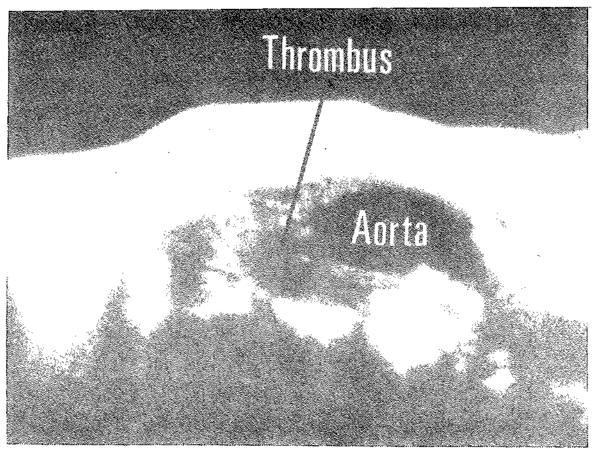

Fig. 9
Longitudinal section showing aneurysm of the abdominal aorta with thick thrombi occluding part of the lumen.

have been notoriously difficult to interpret. With the advent of ultrasound and the availability of transducer probes of various frequencies, the pancreas can be fairly easy to scan. Chronic pancreatitis shows bizarre patterns and areas of calcifications. Carcinoma of the pancreas appears as high level echoes in an enlarged pancreas which may involve the common bile duct causing obstructive jaundice.

Ultrasound has also been used to stage carcinomas of the prostate. For this, a special probe placed in the rectum is required. Occasionally a non-pulsatile mass in the abdomen requires ultrasound diagnosis to confirm abdominal aortic aneurysm. This is shown in Fig. 9 which demonstrates a very thick lining of thrombus in the lumen.

Retroperitoneal tumours and pelvic tumours are occasionally encountered. A dermoid cyst with areas of calcifications is shown in Fig. 8. The calcifications were not seen on the plain radiographs.

Generally no special preparation is required before the patient is scanned. To prevent contraction of the gallbladder, the patient is put on nil orally for at least four hours. For scanning of the pelvic organs, a full bladder is required for two reasons – firstly, to displace the mass into the abdominal cavity and hence making it easier to scan and secondly, the full bladder is used as an acoustic window through which the relatively unattennuated ultrasound beam passes.

Air and bony masses attennuate ultrasound by scatter and absorption. As such, the gastro-intestinal tract, lungs and brain cannot be scanned. Remote areas of the liver and kidneys which are well protected by the ribs are therefore difficult to scan. Scar tissues from previous operations obscure underlying organs and may make interpretation difficult. The head of the pancreas and gallbladder may occasionally be obscured by overlying bowel which tends to attennuate the ultrasound beam.

CONCLUSIONS

From our experience, ultrasound definitely plays a very useful role in narrowing down the diagnosis in many cases involving the liver, pancreas and kidneys. With its introduction, many unnecessary investigations, some of which are invasive, are reduced, Ultrasound scanning is non-invasive and well tolerated by the patients. It has no known hazards as far as we know. It is more economical to run in terms of time and cost in the long run, and allows a different approach to the management of these patients geared towards an early and more accurate diagnosis.

SUMMARY

Ultrasound scanning is a standard procedure in the investigations of lesions of the liver, pancreas and kidney. By its ability to demonstrate dilated ducts in jaundiced patients, it offers a unique advantage over most investigations in distinguishing obstructive from non-obstructive jaundice. Pancreatic lesions such as pancreatitis, carcinoma and cysts can be demonstrated by ultrasound scans. It is the most useful non-invasive technique to detect carcinoma of the pancreas.

In renal lesions, ultrasound has the advantage of being able to distinguish cystic from solid masses. Where the kidney has not been visualised on intravenous urograms, the ultrasound scan is able to demonstrate the renal anatomy fairly well and hydronephrosis, cyst and carcinoma can be shown.

Ultrasound scanning is non-invasive, well tolerated by patients and results are obtained immediately. Its limitations are discussed.

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