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ASPECTS OF DIAGNOSIS*

The diagnosis and assessment of abdominal aortic aneurysms by ultrasonography

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Summary

A study of 150 patients examined by ultrasonography is described. It was designed specifically to diagnose and investigate abdominal aortic aneurysms. Sixty-four aneurysms were found. Ultrasonography was useful in distinguishing aneurysms from other conditions and there was a high degree of correlation between size measured by scanning and operative size. In addition to the demonstration of rupture it was possible to perform serial measurements. The technique is simple and quick and causes minimal disturbance to the patient.

Introduction

Abdominal aortic aneurysms may be difficult to diagnose clinically, especially when the aneurysm is small and the patient stout. Confusion may occur when the patient has lumbar lordosis or when there is an overlying mass with transmitted pulsation. Osler, writing in 1905[1], was well aware of the difficulties, as were Eliason and McNamee[2] in more recent times. Similar diagnostic difficulties occur when an aneurysm ruptures[3]. There is now good evidence that small asymptomatic aneurysms are unlikely to rupture and need not necessarily be resected unless they increase in size or become associated with pain[4]. The monitoring of the changing size of an aneurysm has thus become an important consideration in the management of this condition.

Ultrasonography has achieved steadily increasing recognition as a diagnostic tool in medicine. The simplicity and non-invasiveness of the technique render it particularly attractive in the study of the abdominal aorta[5,6]. Previous studies have been concerned with relatively small numbers of aneurysms and were not extensive. This paper reports an attempt to investigate more critically the usefulness of ultrasonography in a much larger series of patients.

Stobhill Hospital and the Royal Infirmary, Glasgow, are large general hospitals with a mutual interest in vascular surgery. Patients are referred to these hospitals not only from Glasgow but also from many parts of the West of Scotland. Because of this and excellent co-operation with the Radiological Department of Stobhill Hospital, which made available a Kretz ultrasonic scanner, it was possible to undertake a large and fairly comprehensive investigation.

Method

The patients were examined in a room conveniently situated near the emergency admission room and the operating suite. Most were outpatients; a small number were examined as emergencies on admission. The technique used was similar to that described by Leopold[6]. No special preparation was required and the examination could easily be completed within 5–10 minutes. Since barium in the bowel has been reported to give rise to acoustic interference[7] it was thought wise to defer ultrasonography if recent barium examinations had been performed.

Scanning of the abdomen was performed transversely and longitudinally at various

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*Fellows and Members interested in submitting papers for consideration with a view to publication in this series should first write to the Editor

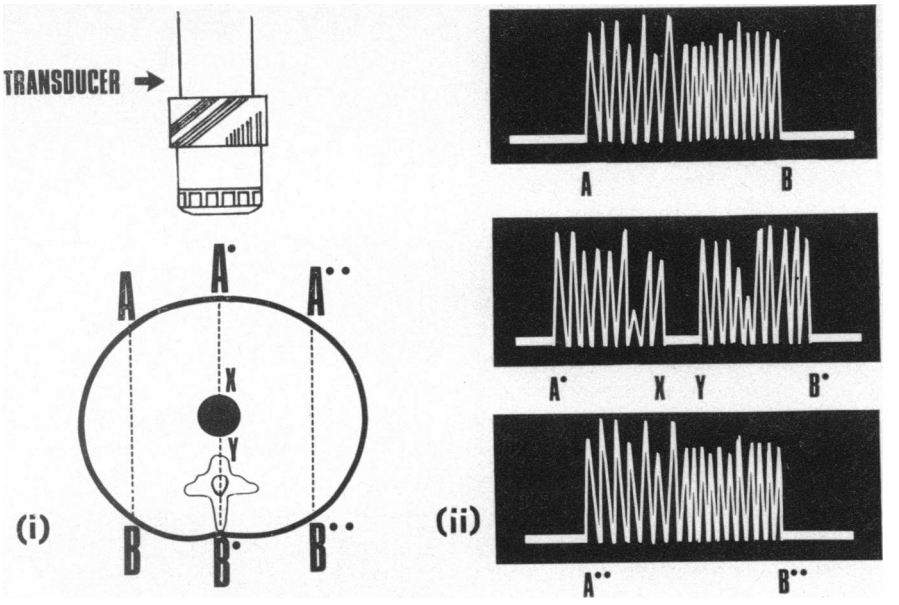

FIG. 1 *(i) Ultrasonic probe or transducer approaching a diagrammatic cross-sectional representation of abdomen. X–Y represents anteroposterior diameter of aorta. The probe is applied to the abdominal wall surface and moved across in the required direction. (ii) Series of A scans obtained in different vertical planes through cross-sectional area of abdomen. The vertical oscillation waves are reflected from various abdominal structures. The intraluminal diameter of the aorta is shown as the portion on A scan for plane A' — B' free of waves (XY). The boundaries of this show expansile pulsation, permitting differentiation from a non-aortic cyst. In some cases it is possible to identify and measure anterior and posterior wall thickness when, as in the diagram, their echoes can be distinguished from non-aortic echoes (note slight reduction and gap in wave pattern on either side of points X and Y).*

levels. The resulting pictures were displayed on oscilloscope screens as A and B scans, which could be photographed for a permanent record. From the A scan measurement of the anteroposterior diameter of the abdominal aorta could be made using calibration markers. The principle of the A scan is shown in Figure 1. The B-scan picture provided a cross-sectional composite display of the whole area scanned; though less reliable for measurements it was useful in detecting the site of maximum dilatation and also the extent of the aneurysm. Measurements at other levels were made to give some indication of involvement of the renal arteries or bifurcation. An approximate estimate of the transverse diameter could be made from the transverse B scan. This was estimated by proportion when the corresponding A-scan anteroposterior measurement was known and compared with the anteroposterior size on the B-scan photographs. In certain instances the ultrasonic examination was repeated on further occasions to assess any changes.

Results

A total of 150 patients (93 male) were examined by ultrasonography between October 1972 and June 1975. Most were referred from vascular outpatient clinics for an assessment of aortic size, but other sources were found (Table I). In some cases the diagnosis of an aneurysm was clinically certain but in others it was not. The criteria for classification of

TABLE I *Referral sources*

Vascular clinics	116
Other clinics	1
Surgical wards	16
Medical wards	6
Emergency	9
Previous laparotomy	2

aortic size in this series were similar to those of Steinberg *et al.*[8] and Leopold[6]. Any value of 30 mm or more was accepted as aneurysmal; 25–29 mm was taken as indicating dilatation; 24 mm or less was considered to be normal.

Using these criteria a total of 64 aortic aneurysms were found or confirmed on screening the 150 patients; 48 of the aneurysms were in males. The appearance of a representative aneurysm is shown in Figure 2. Twenty dilated abdominal aortas were observed and the aortic diameter was considered to be normal in 66 cases. In 6 of the latter group non-aortic disease was present and explained the clinical simulation of an aneurysm; these were pancreatic carcinoma in 2 cases and gastric carcinoma, lipoma of the mesentery, pyloric stenosis, and chronic pancreatitis in 1 case each.

The majority of the aneurysms were infrarenal. Three cases of aneurysm extending above the renal arteries were found. Figure 3 shows one such aneurysm. The average size of the aneurysms measured in this series was 44.2 mm (range 30–80 mm). These measurements were for the anteroposterior diameter. In an initial study of 16 patients with aneurysms measurement at subsequent operative resection showed that in most cases the ultrasonic estimate was within 5 mm of the operative value. This was better than values obtained either clinically or from calcification on X-ray. In 5 of the cases the difference exceeded this because of marked thrombus formation in the wall of the aneurysm. This was found difficult to measure precisely from the A scan, which more certainly estimates the intraluminal diameter[9].

Nine patients were referred for emergency examination. These were cases in which the exact diagnosis was uncertain but a ruptured aneurysm was suspected. Because of the close proximity of the scanning room to the operating theatre such patients could be examined quickly and with minimal disturbance. Eight aneurysms were found, of which 5 were shown to be ruptured and the remainder intact. An example of rupture is shown in Figure 4. The ninth patient had a retroperitoneal haemorrhage due to erosion of the splenic artery from a colonic carcinoma and it was possible to demonstrate by ultrasonography that the clinical presentation was not due to an abdominal aortic aneurysm[10].

A total of 27 patients were scanned on more than one occasion and measurements at comparable levels were taken. Some were cases of definite aneurysm, either small or in patients unfit for elective surgery. In others the initial results had been equivocal or had been categorized as showing 'dilatation'. The results for 10 patients examined on a number of occasions for one year or more indicate in some a gradual increase in size, in some no appreciable change, and in a few apparent diminution in size (Table II). Since the technique was quick and non-invasive and could be performed with minimal upset patient acceptance of repeated examination was excellent. It is hoped

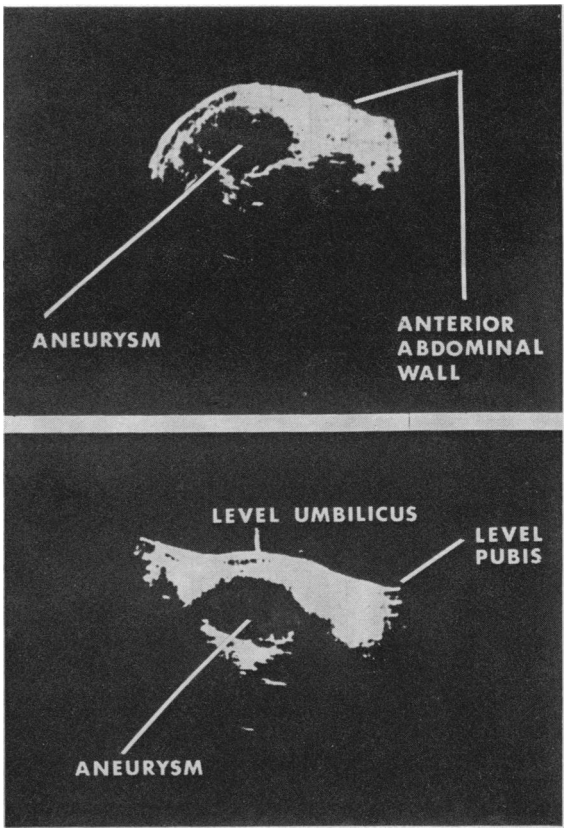

FIG. 2 *Abdominal aortic aneurysm B scan. Upper picture shows aneurysm in transverse section at its maximum anteroposterior diameter (61 mm). Longitudinal profile in lower picture shows clearly shape and extent of aneurysm. It has a narrow neck below where the renal arteries would be expected and expands distally towards the bifurcation (surface marking at level umbilicus).*

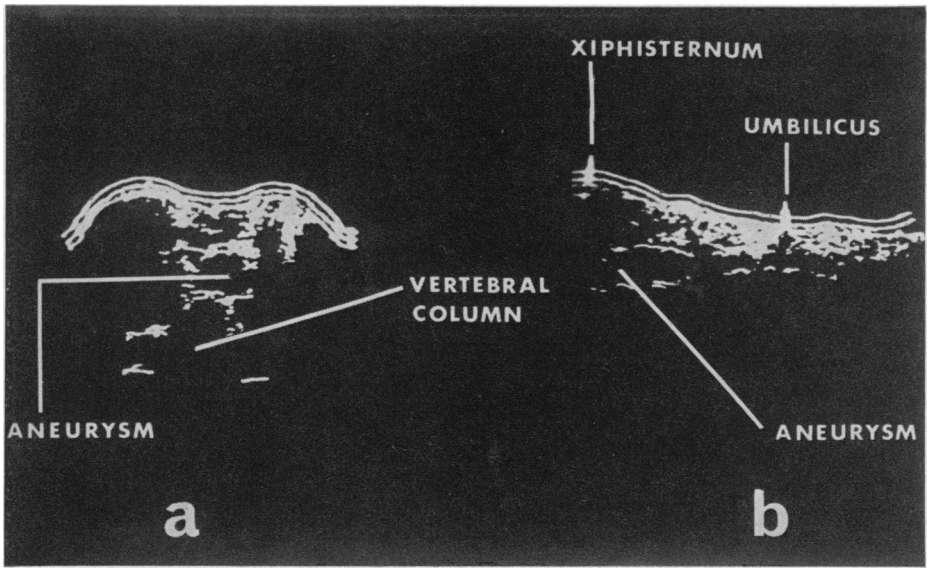

FIG. 3 *Abdominal aortic aneurysm B scan. Transverse scan (a) at a level 4 cm below the xiphisternum shows an abdominal aortic aneurysm lying below the liver. Longitudinal scan for same patient (b) shows aneurysm to extend above level where the renal arteries would be expected (surface marking approximately midway between xiphisternum and umbilicus).*

that measurements over a longer period will be possible in several patients in this group.

TABLE II *Serial study—cases measured over 1 year*

1)	Significant increase	
	Case 1	27–38 mm
	Case 2	47–55 mm
2)	No significant change	
	Case 3	29–31 mm
	Case 4	28–30 mm
	Case 5	29–27 mm
	Case 6	46–42 mm
3)	Apparent decrease	
	Case 7	40–15 mm
	Case 8	36–22 mm
	Case 9	36–20 mm
	Case 10	28–17 mm

Discussion

The diagnosis of an abdominal aortic aneurysm may be made by several methods apart from clinical examination. Some authors have advocated straight and lateral abdominal X-rays to detect curvilinear calcification, but this is present in only about 55% of aneurysms[11]. Aortography requires a general anaesthetic and is not without risk to the patient; it cannot readily be used in emergencies or for serial studies. Radionuclide aortography with intravenous injections of ^{99m}Tc-albumin has been found to be a useful technique in assessing aortic lumen size and may identify intravascular thrombus[12]. Neither contrast nor radionuclide aortography can be relied on to demonstrate the size of an aortic aneurysm

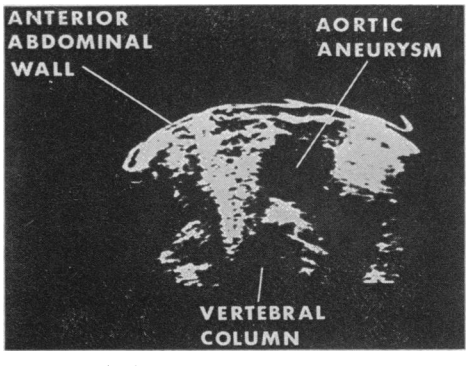

FIG. 4 *Abdominal aortic aneurysm B scan. Transverse scan at level 4 cm above the umbilicus showing moderately large aneurysm with large defect in left lateral wall consistent with rupture. Relatively echo-free area in left paravertebral region represents the haematoma.*

because they only outline the lumen.

There seems little doubt that ultrasonography offers a most attractive method of diagnosing and assessing the abdominal aortic aneurysm. It is safe and rapid and appears to be reasonably accurate. One apparent drawback is in the uncertainty at times in measuring the aortic wall thickness, but this may be less important than it seems if it is accepted that it is the thin-walled aneurysms that are likely to rupture. As a screening procedure ultrasonography has been extremely successful both as an elective and as an emergency procedure. The former provides information regarding the size and extent of an aneurysm. The latter may provide the final confirmation in cases that may otherwise cause diagnostic difficulty[10,13]. The information obtained is useful in planning a vascular procedure.

The results of the serial investigations performed so far indicate that, at least over a period of one year, change in the size of an aneurysm is usually small and cannot be predicted in any one patient. This method of evaluation would appear to be very useful in managing patients whose general physical condition would render other methods of investigation, such as aortography, extremely dangerous if repeated on several occasions. Very little is known about the natural history of the abdominal aortic aneurysm and it is likely that ultrasonic screening over a number of years in suitable patients will provide more information. At present management of an aneurysm is in part dependent on its size, since several authors have shown that larger aneurysms are more liable to rupture than small ones; the critical diameter from various clinical and autopsy studies has been found to be 60–70 mm, the incidence of rupture rising steeply above this[14-17]. Since the mortality of rupture is virtually 100% if untreated and is not inconsiderable even with operation, it is of some importance that surgery be performed at an earlier stage if possible. Although aneurysms of the aorta tend to enlarge, there have been a few reports of sudden complete thrombosis of an abdominal aneurysm[18]. Most of these were smaller than 70 mm in diameter. It is of some interest that in our own series a number of aneurysms appeared to decrease in size, suggesting that thrombus formation was occurring, thereby reducing aortic luminal size (Table II).

In conclusion, ultrasonography has been found to be extremely useful in diagnosing and assessing the abdominal aortic aneurysm, whether intact or ruptured. It is acknowledged that it may not be available in all hospitals, but we believe that its advantages over other means of investigation are such that it should be seriously considered as the method of choice.

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