Ultrasound in the diagnosis and measurement of aneurysms of the abdominal aorta

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Summary

One hundred cases clinically diagnosed as aneurysm of the abdominal aorta were examined by ultrasound. The findings are described and the value and limitations of the method assessed.

In the last decade ultrasound by the B scan or imaging technique has been increasingly used in medical diagnosis. In this country the method has been most widely used in obstetric work, although individual workers have also used this method for imaging renal, hepatic and other abdominal lesions.

Several American authors have reported encouragingly on the use of sonar in the diagnosis and assessment of small series of abdominal aneurysms. However the method does not seem to be widely used in this country and as yet no large British series has been reported. Since February 1971 the authors have assessed by ultrasound all patients referred to the X-ray department, St Mary's Hospital, with a diagnosis of aortic aneurysm. The first 100 suspected cases were reviewed.

Method

A Kretz 4100 MG ultrasound was used in the majority of cases. The most suitable probe was found to be a two-MHz crystal transducer, although in very obese patients a one-MHz transducer was needed. This gives a slightly poorer resolution. Acoustic coupling was accomplished by painting the skin with arachis oil. More recently the authors have used a Nuclear Enterprise Disonograph employing an identical technique.

Ultrasound examinations depend on the production of echoes at interfaces where tissue densities and therefore acoustic impedances change. Therefore in an aorta containing fluid blood only, the lumen will be echo-free. Should clot be present, however, this may show numerous echoes as the gain is increased. The increase in gain must be carried out carefully, as too great an increase will lead to excessive echo formation which will render the A scan unreadable, and then obliterate the B scan.

Results are obtained in two ways. Firstly, on the B scan which produces a two-dimensional section in

FIG. 1. Normal aorta in (a) longitudinal section; (b) transverse section. The diameter was not above 2 cm. m = midline; u = umbilicus; s = symphysis; x = xiphisternum.

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the line of the probe movement, and is recorded on Polaroid film, and secondly on the A scan, where the echoes are recorded as a series of waves. From the A scan measurements are obtained using an electronic cursor. Measurements were carried out in the antero-posterior and transverse planes as far as possible. Transverse measurements of the upper abdominal aorta are not possible, as overlying air-containing lung effectively blocks ultrasound signals.

Criteria for the diagnosis of abdominal swellings by ultrasound were discussed by Freimanis and Asher (1970). Papers by Goldberg and Lehman (1970) and by Nusbaum, Freimanis and Asher (1971) discuss the diagnosis of aortic aneurysms. The latter suggest the diagnosis is confirmed:

(a) if there is a sudden increase in aortic diameter compared with measurements obtained above and below;

(b) in a fusiform dilatation if the diameter exceeds 3 cm at any point.

Discussion

The authors have found sonar to be a very satisfactory method of confirming or excluding the presence of an aortic abdominal aneurysm and in some cases of suggesting an alternative diagnosis. They have long been aware that a small proportion of patients who are diagnosed clinically as having aortic aneurysm will have normal aortas. This mistake is most commonly made in very thin patients where the aorta may be strongly pulsatile and almost subcutaneous. The error can be made even by experienced clinicians. With increasing experience they have found that the demonstration of the external dimensions of the aneurysms and of the presence or absence of clot could be carried out reasonably

quickly. Troublesome interference is sometimes encountered, particularly in obese patients, from gassy distension of the bowel. This causes difficulty in obtaining a precise diameter although it could sometimes be overcome by applying varied pressure to displace the bowel. Figures 2 and 3 show typical appearances of aneurysms at sonar. Variations from the commonly encountered fusiform aneurysms can be shown. For example, gross kinking in the anterior or lateral plane can be identified (Fig. 2).

A major limitation of the method is the impossibility of defining and relating the upper end of the lesion to the renal arteries, information once regarded as vital in planning surgery. Perforce, one has to assume a normal anatomical level for these vessels. A few aneurysms will obviously extend above it and a few will be clearly below it but the majority will extend into this region and it is not usually possible to define their upper limit. Again no indication of the condition or patency of the main visceral vessels can be obtained as at aortography, nor in the authors' experience can the iliac vessels be readily identified. The latter are not infrequently involved in aortic aneurysms.

The modern method of treatment of aortic aneurysms is with replacement by a dacron graft with the original aneurysm left *in situ* and by-passed. Postoperative sonar has been performed on many of these cases and it is usually possible to identify the graft and show its relationship to the original aneurysm (Figs 4 and 5). However, if a graft develops thrombosis or the occasional complication of aneurysm formation at the junction with aorta the authors have found that sonar is not very successful in showing the complication, and aortography will usually be necessary.

FIG. 2. (a) Longitudinal section of the aorta showing fusiform dilatation and kinking in the sagittal plane. Maximum sagittal diameter was 4.5 cm. (b) Transverse section of same aneurysm at the level of the umbilicus. m = midline line; u = umbilicus; s = symphysis; x = xiphisternum.

FIG. 3. Transverse section of a large aneurysm. Maximum transverse diameter was 7 cm and the aneurysm was kinked to the left of the mid-line (m).

FIG. 5. Longitudinal section of abdominal aneurysm showing postoperative dacron graft lying within the aneurysm. u = umbilicus; s = symphysis.

FIG. 4. Longitudinal section of abdominal aneurysm showing dacron graft lying over it and by-passing it. u = umbilicus.

Findings

Ultrasonic examination confirmed that 91 of 100 cases had abdominal aneurysm but showed that five cases clinically diagnosed as aneurysms had normal sized aortas (Fig. 1). Of the remaining four cases, two showed appearances suggestive of pancreatic cysts. One of these cases has been confirmed at surgery. Incidentally, this patient had a laparotomy in another country and was told that he had an aortic aneurysm! The second case thought to have a pancreatic cyst has not so far come to surgery. Of the remaining cases, one considered to be non-aneurysmal by sonar was operated on and the palpable mass was shown to be due to para-aortic glands affected by follicular lymphoma. In the final

case it was not possible to obtain a satisfactory examination because of the patient's gross obesity and gas-distended bowel.

In thirty-five of the cases where a diagnosis of abdominal aneurysm was made by ultrasound the maximum diameters as measured were checked at operation (fifteen cases) or by angiography (thirty cases). In ten cases it was checked by both methods.

Patients who underwent aortography had the measurements of the aortic lumen corrected usually by a factor of 0.75 to allow for the photographic enlargement so produced. The correction figure was obtained by measuring the distance from cassette to anterior surface of the dependent lumbar vertebra as shown on a lateral film. This was then related to the anode film distance used for aortography. Measurements at operation were obtained by calipers directly on the aorta. In all cases except one there was a close correlation between the dimensions as measured by the different methods. In one early case there was a discrepancy and the aneurysm was found to be 11 cm in maximum diameter instead of 5 cm as suggested by the ultrasound. This isolated discrepancy was thought to be due to a fault in technique.

Conclusion

Sonar represents a simple non-traumatic method of confirming a diagnosis of abdominal aortic aneurysm avoiding the discomforts of aortography. It is a method very suitable for follow-up studies in patients not yet considered suitable for surgery. However, its limitations may need to be supplemented by angiography in specific cases where surgery is proposed or post-surgical complications have developed.

Acknowledgments

We would like to thank Mr H. H. G. Eastcott, Mr J. R. Kenyon and Mr Crawford Jamieson under whose care most of these patients were admitted. Most of the operative measurements were obtained by the late Mr Barrie Thomas.

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CORRIGENDUM

December 1977.

In the article 'Ultrasound in the diagnosis and measurement of aneurysms of the abdominal aorta'

by Sutton and Garner. The initials of the second author are E. B. *not* R. G. as printed.

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