Ultrasound screening for aortic aneurysms

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Introduction
The Department of Health in England agreed to fund abdominal aortic aneurism (AAA) screening in 65-year-old men in 2008. Similar screening programmes have been agreed in Scotland, Wales and Northern Ireland. They are being implemented over several years, but most of the UK should be included by 2013.1 The aim of AAA screening is to reduce the number of deaths from AAA rupture – best estimates are that about 5,000 men die in the UK every year from the condition. AAA can be diagnosed easily by abdominal ultrasound, and current programmes offer a single scan for men in their 65th year. Treatment for AAA is widely available and prevents rupture. The Multicentre Aneurysm Screening Study (MASS) showed that this method can reduce the risk of AAA rupture by almost 50%.2 The ultrasound scan is the fundamental component of the programme and it is vital that the individuals who undertake the test are well trained and efficient.3

Workforce and training
It was decided to use a dedicated workforce to undertake ultrasound imaging in the NHS AAA Screening Programme (NAAASP) for England. These screening technicians are recruited from a variety of backgrounds, some outside the NHS, and most will not have had previous ultrasound scanning experience. The technicians (or screeners) all receive dedicated training at a course run by Salford University, delivered locally, consisting of two two-day study blocks. The course is accredited by the Consortium for the Accreditation of Sonographic Education (CASE). Pre-learning material is provided before the first block. In-between each study block the trainees undertake training scans in their own departments under the supervision of their locally appointed clinical skills trainer, typically an experienced sonographer or clinical vascular scientist, who also receives NAAASP training.

The trainee technicians must maintain a logbook and undertake a minimum number of normal and abnormal aortic scans to the appropriate level before they are eligible to attend the second study block. They will also undertake two case studies. At the end of the second study block they have a practical examination where they are observed scanning aortas. Most screening technicians achieve accreditation within three to six months.

Equipment
Two types of ultrasound scanner have been selected by NAAASP for screening and surveillance through a formal tendering process. These are the GE Logiq e and Sonosite M Turbo systems. Both machines are portable laptop scanners and are supplied with low frequency curvilinear transducers. A standard B-mode pre-set has been developed to minimise differences in the image appearance produced by individual screeners. An equipment quality assurance programme has been developed that includes electrical safety, imaging performance and electronic calliper accuracy checks.

Measurement method
NAAASP follows the measurement technique employed in MASS that uses ultrasound imaging to assess aortic diameter. Measurements are made on static images of the maximum diameter of the infrarenal aorta in the anteroposterior plane, from inner anterior aortic wall to the inner posterior aortic wall (ITI). In contrast, many ultrasound departments routinely measure aortic diameter from the outer anterior wall to the outer posterior wall (OTO) (figure 1). Obviously the OTO technique will give a slightly larger reading for aortic diameter compared to ITI. The average difference has been reported to be in the region of 2-3mm. However, while the ITI method gives a lower reading for aortic diameter, there is evidence the method is more reproducible.4 This is particularly important in the context of a national screening programme employing a large workforce, where minimising variation between technicians and scans is imperative.

One possible reason why the ITI method is more reproducible is related to the physics of ultrasound. The intensity of reflected echoes is greater at interfaces between tissues with larger differences in acoustic impedance.5 Acoustic impedance can be thought of as the amount of resistance a tissue offers to the passage of ultrasound. There is a larger difference in acoustic impedance between blood and arterial wall than arterial wall and surrounding peri-aortic tissue. This gives greater confidence in the positioning of the posterior inner wall caliper compared to the outer wall caliper, as the boundary of outer aortic wall and adjacent tissue can be indistinct and in some cases appear to merge (figure 1). One common concern relates to the presence of mural thrombus within the AAA, and the potential for measurement error. Screening technicians are taught to identify mural thrombus within the aortic sac to avoid misidentifying the inner edge of thrombus as aortic wall which would lead to an underestimation of aortic diameter (figure 1).

Scanning technique
Using B-mode imaging, starting in a transverse plane, the aorta is visualised from the midline or sagittal position. The depth should be set so the anterior border of the lumbar spine is clearly visible at the bottom of the image, and the gain and focus position optimised. Starting a few centimetres above the umbilicus the aorta is then imaged along its entire length from just below the xiphisternum to the aortic bifurcation, with the widest point identified and measured using the electronic measurement callipers (figure 2). For most scans the aorta will be of normal calibre, with a relatively uniform diameter along its length, although there can be...
some slight tapering as major branches divide from the aorta. The aorta is then viewed along its length in the longitudinal plane from the sagittal plane and the maximum diameter measured from this position (figure 3). A minimum of two static images displaying maximum aortic diameter from both imaging planes should be recorded for quality assurance purposes. The maximum transverse and longitudinal diameter measurements are also entered onto the NAAASP database. In most circumstances there should be minimal difference between the maximum transverse and longitudinal diameter measurements.

The screening technicians are not taught to image the aorta from other positions such as the coronal plane, as it is more likely that the vena cava or other structures could be incorporated into the measurement of the aorta leading to over-estimation of diameter. Colour flow imaging and spectral Doppler modalities are not used during the examination as the technicians are not taught to use these modes within the technician training programme because they could lead to misdiagnosis. In addition, the screening technicians are not expected to specify if aneurysms are infra or supra-renal and they do not identify major branches of the aorta. A typical image of a small aortic aneurysm is shown in figure 4. Overestimation of aortic diameter can also occur due to the incorrect placement of callipers in longitudinal images where a section of the aorta may run diagonally across the screen. Screening technicians are taught the correct measurement technique, measuring diameter perpendicular to the vessel axis as shown in figure 3.

Presently, all static images are stored by the local programmes for future reference. There is debate nationally about whether this is needed for anything other than training and quality assurance purposes, in which case keeping them in perpetuity might be unnecessary. Possible outcomes from screening are shown in table 1.

Non-visualisation and incidental findings

The main problem encountered by the screening technicians is non-visualisation or non-identification of the aorta due to obesity, or sub-standard imaging due to bowel gas. In these circumstances, if the screener considers it might be possible to obtain an image at a second scan, they can offer another appointment. If not, the patient may be referred to the local hospital for repeat or alternative imaging.

Incidental findings have proved to be a more controversial topic. The role of the screening technicians is purely to identify the aorta and measure its maximum diameter. They are not expected to diagnose or comment on other pathology. For obvious anomalies such as renal cysts, a certain amount of common sense should be employed. The local programme director, who is a consultant vascular specialist, provides clinical advice and the subject’s GP may need to be informed if appropriate.

Ultrasound image quality assurance (QA)

Quality assurance is an essential component of any national screening programme to reduce the probability of errors, maintain standards and help the screening programme to improve year on year. NAAASP has implemented a comprehensive QA process to ensure that screening technicians are performing ultrasound scans to the appropriate standard and this comprises two parts. First, there is regular review of a series of random aortic images by the local programme lead ultrasound clinician. Factors such as image gain and depth settings, as well as accurate placement of callipers, are assessed and recorded on the NAAASP database. Second, six-monthly observational visits are undertaken to watch the screening technicians perform aortic scans. If there is found to be consistent under-performance in either process, retraining or remedial action can be undertaken.

Career progression

Many screening technicians work part-time, and for many the job is a convenient match to their other activities. Others may see the job as the first step in a career in imaging. NAAASP is currently exploring ways to offer career progression either to radiography or vascular science. The present training course is CASE-accredited, but the possibility of obtaining a relevant diploma might enable a planned career pathway.

Conclusion

A fully-functioning AAA screening programme should reduce the rate of AAA rupture by about half. The key to the success of AAA screening is a well-trained and effective workforce of screening technicians. Ongoing quality control and career progression are important to NAAASP and should lead to an effective and contented workforce.

References

1. http://aaa.screening.nhs.uk/

TABLE 1

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<thead>
<tr>
<th>Outcomes of screening.</th>
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<tr>
<td><strong>Aorta 2.9cm diameter or less – man is reassured and discharged</strong> (most men)</td>
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<tr>
<td><strong>Aorta 3.0 to 5.4cm – man enters surveillance programme</strong> (annual imaging 3-4.4cm; three monthly imaging 4.5-5.4cm)</td>
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<td><strong>Aorta 5.5cm or greater – man referred to vascular unit for consideration of treatment</strong></td>
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FIGURE 1

A longitudinal image of an abdominal aortic aneurysm. The white straight arrows indicate the position of the anterior and posterior inner walls (ITI method). The black arrows show the position of the outer anterior and posterior walls (OTO method). The curved arrows show thrombus within the sac of the aneurysm and it is important that measurement callipers are not placed at these positions. The boundary of the posterior wall is more distinct at the point between thrombus and inner wall at the tip of the downward pointing white arrow than the outer wall and surrounding peri-aortic tissue shown by the tip of the upward pointing black arrow.”

FIGURE 3

A mini-table of the outcomes of screening.
FIGURE 2
A transverse image of a normal abdominal aorta. The anterior border of the lumber spine is visible at the bottom of the image.

FIGURE 3
A longitudinal view of the aorta demonstrated in figure 2. The aorta appears to curve gently across the image and the line of measurement is taken perpendicular to the vessel axis rather than parallel to the edge of the screen to avoid over-estimation of diameter.

FIGURE 4
An example of a small abdominal aortic aneurysm measuring 4.9cm in diameter. This patient would undergo three-monthly surveillance.