Clinical Imaging 40 (2016) 321–324

Contents lists available at ScienceDirect

Clinical Imaging

journal homepage: http://www.clinicalimaging.org

Screening for abdominal aortic aneurysms

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ARTICLE INFO

Article history:
Received 23 October 2015
Accepted 24 December 2015

Keywords:
abdominal aortic aneurysm
screening
ultrasound
smoking

ABSTRACT

Ultrasonography remains the screening modality of choice for abdominal aortic aneurysms despite many advances in imaging modalities. Several randomized trials were performed that demonstrated the effectiveness of ultrasound-based screening to reduce aneurysm-related mortality. Ultrasound is both cost effective and low risk. Controversies do persist in selecting the appropriate populations for screening, and several national societies have set recommendations.

1. History of AAA

Aortic aneurysms are common, with a prevalence of almost two million and incidence of almost 200,000 annually in the United States. Large aneurysms are at increasing risk for rupture, with high mortality (approximately 80% fatal) [1]. Abdominal aortic aneurysm (AAA) rupture is the 13th leading cause of death in the US [2]. As there is no effective medical treatment for aneurysms, they must be identified and treated electively prior to rupture for optimal outcomes. With improvements in medical care, and the increasing use of endovascular techniques, the morbidity of elective repair is decreasing. There is a growing body of evidence to support screening in certain populations to reduce to risk of aneurysm-related death.

The aorta is considered aneurismal when its diameter exceeds 3 cm, or 1.5 times its original diameter. This is thought to occur for a multitude of reasons related to structural remodeling of the arterial wall. There is a loss of elastic lamina and smooth muscle cells. Additionally, there is an increase in matrix metalloproteases and inflammatory markers [3]. The result of these changes is the gradual thinning and weakening of the aortic wall, until the ultimate rupture of the wall by the overdistention of collagen fibers.

There are known risk factors for aneurysm formation. Aneurysms are increasingly common with advanced age, tobacco smoking, and hypertension. AAA is more common in men (4:1) and Caucasians.

2. Screening Modalities

The World Health Organization (WHO) has outlined principles for disease screening [4]. These principles address the natural history and treatability of a specific disease, as well as the availability, reliability, and risk of a specific test. In order to be considered an effective screening test, the modality must fulfill certain criteria. The test should be both reliable and reproducible. It should be low cost and should pose minimal or no risk to the patient undergoing the test. The test should be both sensitive and specific. AAAs meet the WHO criteria of a screenable disease. There is a clear latent phase in the disease, which occurs in a high-risk population. The preferred test, duplex ultrasound, is acceptably safe and reliable and demonstrably saves lives through early detection, as there are clear guidelines for intervention.

3. Ultrasound

Ultrasonography fulfills these criteria for aneurismal disease. It is an inexpensive and noninvasive technique. With a trained technician, there is a very high level of reliability and reproducibility. The aorta is scanned from the renal arteries to the aortic bifurcation. The angle of the probe can be adjusted to remain perpendicular to the direction of blood flow, allowing for true orthogonal measurements (Fig. 1) [5]. The maximal aortic diameter is determined through transverse and anterioposterior measurements. The inner-to-inner diameter (ITI) is taken with electronic calipers. A higher degree of reliability and reproducibility was seen when the ITI was used rather than outer-to-outer diameter (OTO). In one study, the reliability coefficient between technicians was 0.30 cm (ITI) versus 0.42 cm (OTO). The reproducibility was also better for ITI than OTO (0.14 vs. 0.21) [6]. Ultrasound is an excellent and safe imaging modality.

Despite its clear benefits, there are multiple modeling studies that suggest that ultrasound measurements do underestimate the size of aneurysms compared to computed tomography (CT) reconstructions. Given a variability of 0.2 cm ± 0.3 cm, it is reasonable that patients with aneurysms >5 cm by ultrasound undergo secondary evaluation with CT angiography (CTA) [7].

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http://dx.doi.org/10.1016/j.clinimag.2015.12.009
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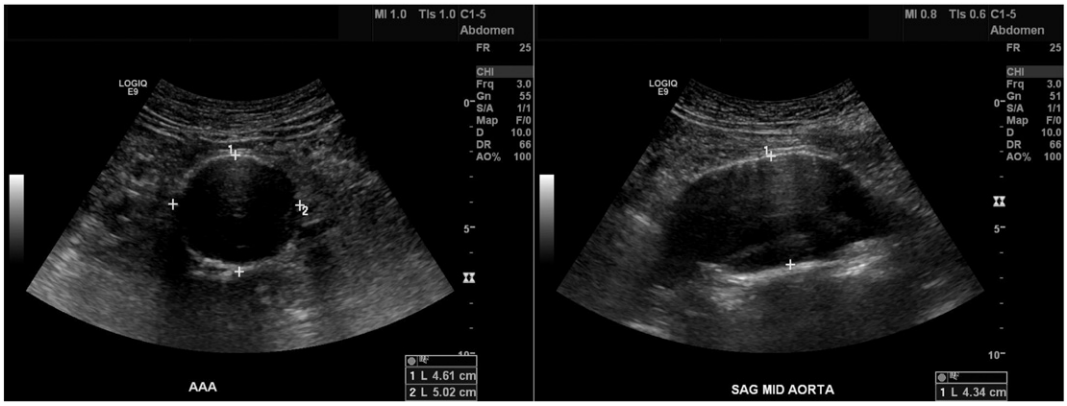

Fig. 1. Ultrasound images of AAA in axial and sagittal views. Grayscale ultrasound enables rapid screening of patients with highly reliable and reproducible measurements. Courtesy of Vascular Lab Medstar Washington Hospital Center.

4. CTA

While CTA has become the standard for operative planning as well as surveillance after repair, it is not a suitable modality for screening. CTA with a multidetector spiral scanner can rapidly scan a patient from chest to pelvis, allowing visualization of the entire aorta (Fig. 2). It is very rapid, and reliable. There is a nonzero risk to the patient, however, due to the use of iodinated contrast and exposure to ionizing radiation. Further, there is a significant financial cost to CTA that renders CTA an inappropriate screening modality. Occasionally, patients who undergo CTA to assess their AAA can subsequently be followed with ultrasounds, obviating the need for serial exposure to contrast and radiation. Duplex ultrasound has been shown to be more reliable in the assessment of maximal aortic diameter than axial CT [5]. Through image postprocessing programs, three-dimensional reconstructions of the AAA can be generated (Fig. 3) [8]. From these reconstructions, true orthogonal measurements can be made [9]. While valuable for operative planning, these reconstructions are not practical or necessary for use on a screening basis.

5. Screening Trials

A number of screening trials have been performed worldwide, which led to implementation of ultrasound screening programs. The first randomized controlled trial was performed in the UK from 1988 to 1993 [10]. Over 15,000 men and women ages 65–80 years were randomized to the ultrasound screening group or control group. Patients were scanned, and those with aneurysms were followed annually (3–4.4 cm) or every 3 months (4.5–5.9 cm). At the end of 5 years, 68.4% of those randomized to screening were screened, with an AAA prevalence of 4%. In the male subset, there was a 55% reduction in rupture (9 patients versus 16 in the control group), which was statistically significant.

A second trial performed in Denmark from 1994 to 1998 enrolled all men in a particular county (Viborg) between the ages of 65 and 73 years [11]. A total of 76% of the 6339 men randomized to the screening arm underwent screening, with a 4% prevalence of AAA. At the end of 5 years, the study demonstrated a 70% reduction in rupture. More patients in the screening arm underwent surgery and underwent elective surgery.

The study performed in Perth, Australia, randomized 41,000 men to screening or a control group [12]. Of the screened population, 7.2% has AAA. In the subgroup of men ages 65–74 years, screening led to decreased aneurysm-related mortality.

The largest of these trials, the Multicenter Aneurysm Screening Study (MASS), randomized men ages 65–74 years [13]. The screened population was found to have a decreased rate of rupture, aneurysm-related death, and all cause mortality.

These findings support screening in specific populations but cannot support broad population-based screening initiatives, and these studies have formed the basis for national and societal guidelines.

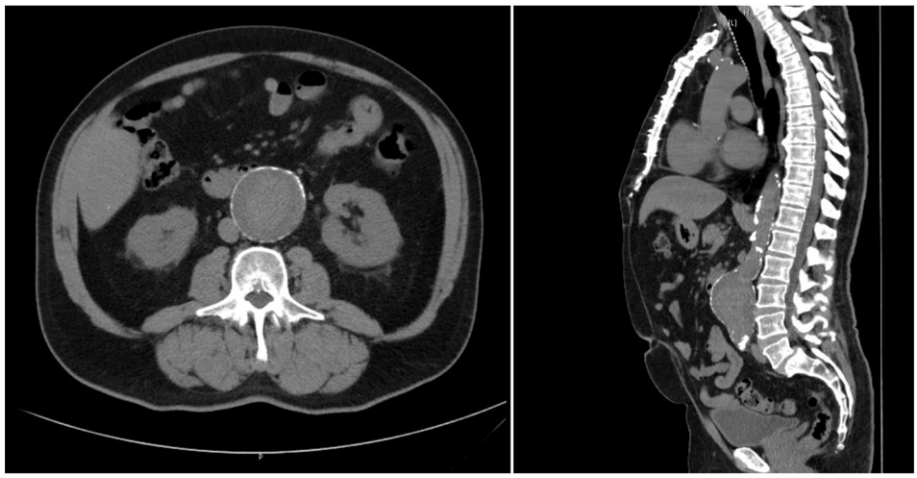

Fig. 2. CT of AAA in axial and sagittal views. CT scans allow for rapid evaluation of the entire aorta. Due to the angulation of the aorta within the body, axial images may not represent the true aneurysm diameter. Courtesy of Medstar Washington Hospital Center.