The American Journal of Surgery 195 (2008) 322–328

Project PROMIS: Peoria Regional Outpatient Medical Imaging Study

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Manuscript received November 15, 2007; revised manuscript December 12, 2007

Abstract

Background: Abdominal aortic aneurysm (AAA) accounts for >15,000 reported deaths annually. Early screening in high-risk populations is important to decrease morbidity and mortality from rupture.
Methods: A prospective, population-based study of free ultrasound-based AAA screening was conducted from July 2004 to December 2006. Before examination, subjects completed surveys asking their medical history, including known AAA risk factors. Incidence rates and comparison analyses were performed.
Results: The final analysis included 979 patients, of whom AAA was discovered in 27 (2.8%). AAA was found in only male patients >60 years old (4% of the male population). AAA size ranged from 3 to 10 cm. Of patients diagnosed with AAA, 85% were current or past smokers, and 70% had hypercholesterolemia. There was a 6% incidence of AAA in male smokers ≥60 years old who had hypercholesterolemia.
Conclusions: Four factors were predominant in our population of patients with AAA: patient age, male sex, smoking history, and hypercholesterolemia.

Keywords: Abdominal aortic aneurysm; Abdominal aortic aneurysm ultrasound examination; Screening program

Abdominal aortic aneurysm (AAA) is an enlargement (ballooning) of the aorta, defined as twice the expected normal size, caused by weakening of the vessel wall. The most common site for this aneurysm in the abdominal aorta is the infrarenal section [1]. AAAs grow at variable rates, sometimes taking 10 to 20 years (average annual growth rate .3 to .6 cm) to develop into a size considered dangerous (5 to 5.5 cm) [2]. Other AAAs may develop and grow rapidly. Although the cause of this weakening is not entirely understood, many factors have been found to play a role in the growth process. Alteration in the level of matrix metalloproteinases and inhibitors of these enzymes may result in an autodigestive process whereby the normally strong wall of the abdominal aorta is weakened [3]. Several risk factors also contribute to an increased incidence of AAA, including age >55 years old, strong genetic susceptibility, smoking, and presence of hypertension, hypercholesterolemia, atherosclerotic plaques, heart disease, peripheral vascular disease, and carotid artery disease [4–6].

Most patients are unaware of AAA until the patient or physician palpates a mass, which is difficult in an obese patient or in a patient with a small AAA [7]. An AAA is often found incidentally during diagnostic imaging by ultrasound, computed axial tomography or magnetic resonance imaging for other diseases, such as gallbladder or gastrointestinal disease, or for cancer staging and metastatic evaluation. Patient with AAAs sometimes develop some back pain, which is often erroneously misdiagnosed as an orthopedic condition. Occasionally these patients may also develop abdominal tenderness, or the AAA may even embolize to their lower extremities from a thrombus lining the aneurysm wall. Otherwise, they are usually symptom free. When patients With AAAs are symptomatic, it is an urgent indication for surgery or repair. This is sometimes described as a "syndrome of impending rupture." The unfortunate fact is that too often an aneurysm is discovered on rupture, with the first symptoms being vascular collapse and shock [1].

Although the diagnosis of AAA may be established by physical examination, objective tests documenting the size of the AAA are required. Abdominal x-ray can establish a diagnosis by demonstrating calcifications in the wall of the aneurysm; however, accuracy of size and location is difficult to obtain, and not all aneurysms will have calcifications

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0002-9610/08/$ – see front matter
doi:10.1016/j.amjsurg.2007.12.025

of the wall. Computed axial tomography and magnetic resonance imaging scans are also available and definitive in making a diagnosis; however, the high cost per test makes these studies less desirable. Ultrasonography is a quick, relatively inexpensive, noninvasive, and reliable method for the diagnosis and sizing of AAAs (sensitivity >98% and specificity almost 100%) [8].

Methods

Study design

Project PROMIS (Peoria Regional Outpatient Medical Imaging Study) was an Institutional Review Board–approved, population-based ultrasound AAA screening study in the Peoria and central Illinois area. Our primary objective was to identify patients with unknown AAAs and the risk factors exhibited, thereby decreasing the number of deaths caused by rupture by way of early diagnosis. By identifying smaller aneurysms (<5 cm), or identifying aneurysms before they ruptured, patients could be informed and educated about their AAAs. Therefore, with patient consent, primary physicians were sent a letter discussing screening results.

Patients were recruited by way of multiple media and advertising outlets (Fig. 1) to voluntarily undergo a free, noninvasive ultrasound examination to determine the largest diameter of the abdominal aorta. Patients who scheduled an appointment to enroll in the research protocol were asked on arrival to sign the consent form. They were then required to complete questionnaires (Fig. 2) detailing pertinent medical history, which placed special focus on AAA risk factors. Ultrasounds were completed by registered vascular technologists in an Intersocietal Commission for the Accreditation of Vascular Laboratories–certified vascular laboratory and evaluated by one of the investigators (A. C. C.), who is also a registered vascular technologist and board-certified vascular surgeon. During each ultrasound, a screening worksheet was completed by the RVT, who noted bilateral brachial blood pressure readings, aortic blood flow velocity and waveform measurement, measurement of aortic dimension at three locations, presence of thrombus, and other incidental findings. On completion of their ultrasounds, all patients received information about AAA with regard to risk factors, etiology, diagnosis, and treatment. Those patients in whom AAA was diagnosed received similar information and were referred to their primary physicians for further testing or to vascular surgeons. The majority of the AAA-positive patients were seen immediately by one of the investigators (A. C. C.) to discuss their situations.

Our inclusion criteria were based loosely on the published Society for Vascular Surgery (January 2004) special communication, which recommends screening for all men 60 to 85 years old, for all women 60 to 85 years old who have cardiovascular risk factors, and for all people >50 years old who have a family history of AAA [9]. We also screened patients much younger and much older than the recommended age criteria who had strong concerns because of a multiperson family history of ruptured AAA. Regarding diagnostic criteria, if the maximal abdominal aortic diameter wall measurement was <2.9 cm, the results were considered normal. AAA was diagnosed if the maximal abdominal aortic diameter wall measurement was ≥3.0 cm. Based on the same communication previously mentioned, we recommended subsequent surveillance of screened patients as follows: (1) aortic diameter <3 cm = no further testing; (2) AAA 3 to 4 cm in diameter = yearly ultrasound examination; (3) AAA 4 to 4.5 cm in diameter = ultrasound examination every 6 months; and (4) AAA >4.5 cm = referral to a vascular specialist.

Technical protocol

Thirteen registered vascular technologists performed all AAA ultrasound screenings primarily using the Philips 5500 with 3540 abdominal probe (Philips, Bothell, WA). Patients were scheduled for morning examinations to minimize bowel gas obstruction of the abdominal aorta. Adequate patient preparation was fundamental to obtaining accurate ultrasound images of the infrarenal segment of the abdominal aorta. Patient instructions, along with the time and date of examination, were given by telephone or mail. Instructions included eating a low-fiber diet the evening before the examination. Patients were told to fast after midnight except for taking small sips of water with their morning medications. If some patients were diabetic, light small breakfast was allowed if their morning glucose levels were acceptable. Diabetic patients were also told to bring milk and a sandwich to eat after the examination.

On entering the examination room, the test procedure was explained to the patient, and questions were answered. It was verified that the patient had followed the dietary instructions. The blood pressure of both arms was obtained and documented before the ultrasound examination, unless a patient refused measurement in one or both arms for medical reasons. The patient was placed in a supine position on a height-adjustable cart and draped for privacy while exposing the abdominal torso. Warmed water-soluble gel was applied just below the xyphoid process midline to the navel.

All technologists adhered to the following ultrasound procedure. The scan was begun in cross-section in the proximal abdominal aorta at the level of the xyphoid process. The celiac axis was identified, and the probe was then turned to the longitudinal position with the index marker cephalad. Aortic peak systolic velocity using a 60-degree Doppler angle and waveform configuration was obtained at the level of the origin of the superior mesenteric artery. The transducer was then rotated 90° counter-clockwise. The first aortic-diameter measurement was made from outer wall to outer wall. The transducer was then moved distal to the level of the renal arteries. A second aortic-diameter measurement was obtained just below the renal arteries and recorded. The transducer was then moved toward the navel to identify the origin of the common iliac arteries. The third aortic-diameter measurement was recorded just above the aortic bifurcation. All areas of atherosclerotic disease and plaque characteristics were also noted on the AAA screening worksheet.

It was crucial that the infrarenal segment of the abdominal aorta and the aortic bifurcation were carefully interrogated because they are the most common site for aneurysm formation. Maximal outer wall–to–outer wall diameter in