Eur J Vasc Endovasc Surg **19**, 299–303 (2000)
doi:10.1053/ejvs.1999.1002, available online at http://www.idealibrary.com on IDEAL®

Abdominal Aortic Aneurysm: the Role of Clinical Examination and Opportunistic Detection*

C. D. Karkos†, U. Mukhopadhyay, I. Papakostas, J. Ghosh, G. J. L. Thomson and R. Hughes

Department of Surgery, Royal Preston Hospital, Preston, England, U.K.

Objectives: *to investigate the method of discovery of abdominal aortic aneurysms (AAA) in a district general hospital setting.*
Design: *retrospective study.*
Materials and methods: *we analysed 198 patients with an AAA who presented to our unit over a 3-year period. The method of initial diagnosis, size of the AAA and whether this was palpable, irrespective of the method of detection, were recorded.*
Results: *ninety-five (48%) were discovered clinically, 74 (37.4%) during a radiological investigation, and 29 (14.6%) at laparotomy. Of the 74 AAAs first detected radiologically, subsequent physical examination showed that 28 (37.8%) were in fact palpable and missed at presentation. The average size of those discovered clinically (6.48 ± 1.32 cm) was larger than those found radiologically (5.37 ± 1.44 cm, $p<0.001$) or at operation (5.43 ± 1.48 cm, $p=0.039$). The average diameter of the palpable AAAs was also greater than that of the non-palpable AAAs (6.42 ± 1.24 cm vs. 4.86 ± 1.38 cm, $p<0.001$).*
Conclusions: *opportunistic detection of a clinically unsuspected aneurysm during clinical examination or investigation for another reason is the most common way the diagnosis of an AAA is made. Almost half of the aneurysms were diagnosed clinically, but physical examination also missed more than a third of those detected radiologically. Despite technological advancement, clinical examination still plays a paramount role in the detection of AAAs. Larger AAAs are usually palpable and more likely to be detected on clinical examination.*

Key Words: Abdominal aortic aneurysm; Physical examination; Opportunistic detection.

Introduction

Abdominal aortic aneurysms (AAAs) primarily affect elderly males (sex ratio 4:1) with a prevalence up to 5%, and account for over 11 000 admissions per year in England, encompassing approximately 3000 elective operations and 1500 emergency procedures.[1,2] In Britain, ruptured AAAs account for an estimated 10 000 deaths per year.[3] In the United States, AAAs were responsible for 16 402 deaths in 1990.[4] Although elective aneurysmectomy has been associated with a constant decline in operative mortality to nearly 5% during the past decade, unfortunately, a similar decline has not occurred for ruptured AAAs, with mortality rates persisting in the 50% range.[5,6] However, the overall risk of death from ruptured AAA is even higher, approaching 80–90%, as less than half the patients reach the hospital alive.[7] Therefore, AAA rupture is commonly a catastrophic and lethal event. Early detection of asymptomatic AAAs has been advocated to decrease the high mortality rate of ruptured AAAs. The majority of AAAs are asymptomatic and found on either physical examination or during a diagnostic investigation for another disease or symptom.[8,9] The aim of this study was to examine how AAAs were detected in a district general hospital setting, whether those not detected clinically were palpable, and what size most AAAs are when they are discovered clinically.

Materials and Methods

During a 3-year period, from April 1995 to March 1998, 244 AAAs have been diagnosed at our hospital. The medical records of these patients were retrospectively reviewed. The method of initial diagnosis, size of the AAA at initial diagnosis and whether this

* Part of this work was presented as an abstract at the 13th Congress of the European Chapter of the International Union of Angiology, EUROCHAP '99, Rhodes, Greece, 26–30 May 1999.
† Please address all correspondence to: C. D. Karkos, Victoria Court, Blackpool Victoria Hospital, Blackpool FY3 8NR, England, United Kingdom.

1078–5884/00/030299+05 $35.00/0

was palpable, irrespective of the method of detection, were recorded. Patients were divided into three groups, depending on how the diagnosis of an AAA was first made: (I) clinically, (II) during a radiological investigation, and (III) during an operation. Aneurysm sizes were confirmed by ultrasonography (US) and/or computed tomography (CT) scan.

For practical reasons, AAA was defined as an abdominal aortic dimension ≥ 3.0 cm. Not all authors define an AAA the same way.[10–12] The Ad Hoc Committee on reporting standards (Society for Vascular Surgery and North American Chapter, International Society for Cardiovascular Surgery (SVS/ISCVS)) defines it as a permanent localised dilation of an artery having at least a 50% increase in diameter compared with the expected normal diameter. Moher *et al*., using the above criteria of the SVS/ISCVS, determined the mean diameter of the infrarenal aorta (20 mm) for 141 unaffected men (maximum infrarenal aorta <30 mm) and then multiplied this by 1.5.[12] For reasons of simplicity, in our practice, we use Moher's definition of an AAA as an infrarenal adominal aortic dimension of ≥ 3.0 cm. This definition has general, if not universal, acceptability.

The clinical records of patients, in whom an AAA was first discovered radiologically, were retrospectively analysed to determine whether the aneurysm was palpable or not on subsequent physical examinations, when the diagnosis was already known. Sufficient data for analysis were available in 198 patients who comprised the study population. Of these, 48 did not have confirmation of their size by US or CT, as they presented as emergencies, having ruptured their aneurysm, and there was no time for diagnostic imaging. They were diagnosed either at the operating theatre or at post-mortem examination, and were excluded from further analysis, leaving 150 AAAs for statistical comparisons. Results are expressed as mean $\pm$ standard deviation. Analyses were performed using the statistical package Statistica™ Release 4.1 (Copyright StatSoft, Inc. 1991–94). Statistical significance was examined using the Student's *t*-test and analysis of variance. Results were considered statistically significant at the $p \leq 0.05$ level.

Results

Of the 198 patients, 154 (77.7%) were men with an age range between 51 and 93 (mean 73.16 ± 7.62) years, and 44 (22.3%) women who ranged in age from 63 to 91 (mean 76.77 ± 7.13) years. The presence of associated hypertension, ischaemic heart disease, smoking, diabetes, peripheral vascular and cerebrovascular disease, chronic obstructive airways disease, and renal impairment was recorded (Table 1).

Table 1. Patients' details.

Clinical characteristics	Men $n=154$	Women $n=44$	Total $n=198$
Ex-smokers	53	6	59
Current smokers	47	12	59
Hypertension	75	23	98
Ischaemic heart disease	90	23	113
Diabetes	9	3	12
Peripheral vascular disease	28	7	35
Cerebrovascular disease	13	1	14
Chronic obstructive airways disease	41	7	48

Table 2. Disease or symptoms for which the 35 patients were evaluated when AAAs were incidentally detected on physical examination.

Symptoms	*n*
Non-specific abdominal pain	11
Change in bowel habits	6
Indigestion, peptic ulcer disease	5
Weight loss	4
Peripheral vascular disease	3
Cerebrovascular disease	3
Inguinal hernia	3
Popliteal aneurysms	2
Genito-urinary symptoms	2
Gallstones	1
Ischaemic heart disease	1
Intestinal obstruction	1

Ninety-five (95/198, 48%) AAAs (group I) were discovered clinically on physical examination; of these 47/198 (23.7%) were "symptomatic" aneurysms, 35/198 (17.7%) were found during examination for another disease or symptom (Table 2), and 13/198 (6.6%) on routine check-up.

A further 74 AAAs (37.4%) (group II) were discovered during a diagnostic investigation for another disease or symptom. The most frequent diagnostic investigation used was US scan (44 AAAs); the rest of the 74 AAAs were diagnosed by CT scan (12/74), arteriography (10/74), plain abdominal films, kidney–ureters–bladder (KUB) X-ray, or lumbosacral spine X-rays (5/74), intravenous urography (2/74), and barium enema (1/74). The indications for the diagnostic investigation during which an AAA was incidentally detected are analysed in Table 3.

Finally, the remaining 29/198 (14.6%) AAAs (group III) were discovered at laparotomy without preoperative diagnosis. Eight AAAs were found incidentally during operations for another entity (diverticular disease in three, colonic carcinoma in two, small-bowel obstruction in two, and perforated

Table 3. Diseases or symptoms for which the 74 patients were investigated when aneurysms were incidentally detected during diagnostic imaging.

Symptoms	*n*
Urological symptoms	15
Peripheral vascular disease	14
Non-specific abdominal pain	13
Gallstones	10
Abdominal–pelvic malignancy	6
Back pain	4
Chronic renal failure	4
Change in bowel habits	4
Pancreatitis	2
Intestinal obstruction	1
Septicaemia	1

duodenal ulcer in one). None were palpable on admission. No calibres were used to measure the aneurysm size intraoperatively. Their exact size was estimated by ultrasonography in the postoperative period. The other 21 patients underwent urgent exploration for a suspected ruptured AAA or acute abdomen. These 21 patients were found to have ruptured AAAs which were non-palpable preoperatively and there was no time for diagnostic investigations.

After excluding the 48 AAAs whose exact size was not estimated by US or CT scan, as there was no time for diagnostic studies, 150 patients, 113 men and 37 women, were left for statistical analysis. Their diameter ranged from 3 cm to 10.5 cm with a mean of 5.88 ± 1.48 cm. The average size of those AAAs discovered clinically (6.48 ± 1.24 cm) was larger than those detected radiologically (5.37 ± 1.44 cm, $p<0.001$) or at operation (5.43 ± 1.48 cm, $p=0.039$). No statistical difference in medical risk factors was found.

Of the 74 AAAs first discovered radiologically, 28 (37.8%) were in fact palpable and were missed at initial assessment. These ranged from 5.2 cm to 8 cm in size with a mean of 6.21 ± 1.02 cm. No attempt was made to identify how many of these patients had physical examination specifically looking for an AAA. In view of the retrospective nature of this study and considering how notes are written in the modern medical practice, this would have been impractical. Overall, 46 (62.2%) AAAs were not palpable on physical examination, even when the diagnosis was known. Their size ranged from 3 cm to 10.5 cm with a mean of 4.84 ± 1.41 cm ($p<0.0001$). The average diameter of the palpable AAAs was greater than that of the non-palpable AAAs (6.42 ± 1.24 cm vs. 4.86 ± 1.38 cm, $p<0.001$).

Discussion

About 75% of AAAs are asymptomatic.[8,9] They come to light as the chance findings of a lump with or without pulsation, noted on self-examination, a routine physical check-up, or during diagnostic investigations, such as a plain abdominal film, intravenous urography, barium, US, CT, or magnetic resonance-imaging study, undertaken for some other reason. The aneurysm may also be found at laparotomy or post-mortem examination. Abdominal and/or back pain is the most common symptom of an AAA and may be acute or chronic and is due to stretching of the aortic wall. In 50% of these, the aneurysm had ruptured. Nearly one-third of patients who present with a ruptured AAA were not previously known to have an aneurysm.[13] Patients may also present with distal embolisation ("trash foot" or "blue toe syndrome"), thrombosis, and duodenal or ureteric compression.

Early identification of AAAs may reduce the risk of death from rupture by providing the opportunity for elective repair. Although physical examination can readily identify some aneurysms, equally, many will be missed, even by the most experienced clinicians. Many authors have found clinical examination to be a poor method of detecting AAA.[1,14–21] Failure to diagnose an aneurysm clinically may be due to inexperience, poor clinical skills or examination technique, and failure of the examining doctor to direct his examination specifically towards AAA detection.[14,15] It seems likely that the sensitivity of examination by an experienced vascular surgeon looking specifically for AAAs is greater than that of "routine" physical examination.[14,15] As newer diagnostic tests have inevitably relegated the physical examination to junior and less experienced medical staff, it is probable that many AAAs are being overlooked.[16] On the other hand, clinical examination may be unreliable in certain patients in whom the aorta is impalpable due to heavy muscular build, obesity, abdominal distension, and ascites. Furthermore, transmitted pulsations from hyperdynamic aortas or other retroperitoneal structures may give the false impression of an aneurysm during physical examination in thin patients and those with tortuous aortas.[16]

In this series, almost half of our patients were diagnosed clinically as having an aneurysm, but physical examination also missed more than a third (37%) of AAAs detected radiologically. Opportunistic detection of a clinically unsuspected aneurysm is the most common way the diagnosis of an AAA is made today and accounted for approximately two-thirds (65.6%) of our patients. Therefore, every clinician should maintain a high index of suspicion for an AAA when examining

"high risk" patients, such as elderly Caucasian men, smokers, patients with peripheral or cerebral arterial disease, hypertension, chronic obstructive airways disease, inguinal hernias, family history of AAA, and the presence of other peripheral aneurysms.[14,22–29] In those where physical examination is suggestive of an AAA or in whom the aortic pulse cannot be palpated, an abdominal US scan should be undertaken.[22] Lederle *et al*. found that physical examination is an adequate way of screening thin patients. For those patients who are obese, have abdominal distension and whose aorta is impalpable, ultrasonography is the method of choice.[15]

Aneurysm diameter is a major determinant of the risk of rupture, which is approximately 20.5% over 5 years for an AAA with an initial diameter of 4.5 cm.[30] In this series, 28 of the 74 radiologically discovered AAAs were palpable, but remained unrecognised on initial clinical assessment. Although one might argue that missing a small (<4.5-cm) aneurysm is not clinically important, in this study, the palpable aneurysms that were missed on initial clinical assessment had a mean diameter of 6.21 ± 1.02 cm, size which requires immediate repair. Not surprisingly, AAAs detected clinically were larger than those discovered incidentally during investigations or at laparotomy. Since this was a retrospective study, it was not possible to determine how many of these patients did have, on admission, abdominal examination that included assessment of the aortic width. It is likely that some of the patients did not have abdominal examination at all, some others had abdominal examination recorded as "NAD" (no abnormality detected) without estimation of the aortic width, and, finally, some had a complete physical examination including looking for an AAA, although the latter may have not been specifically documented in the notes. Therefore, the validity of the above figures is somewhat low, but this is a limitation arising from the retrospective nature of our study. A similar prospective study would, perhaps, yield much more accurate information.

One might question why a cut-off point of 3 cm was chosen for this study, and not a larger diameter which might be of higher clinical importance. If the very small and clinically insignificant aneurysms were excluded using a cut-off point, for example, of 4 cm, then the proportion of clinically detected AAAs would increase when compared to those discovered radiologically or during a laparotomy. That is a frequent problem in AAA literature and the effects of differing definitions are well-recognised.[12] Although smaller AAAs are clinically insignificant, we included them in this study as they still consist part of the workload of a vascular unit in daily practice.

Abdominal US and CT scan were the two most common investigations, responsible for the opportunistic detection of 56 (75%) of the 74 aneurysms found during radiological procedures. Derbyshire *et al.* found that the prevalence of AAA in male patients aged 65–74 undergoing non-vascular abdominal ultrasonography was 5%.[31] Similarly, Fowl *et al.* reviewing all abdominal CT scans ordered in male veterans >50 years for reasons other than aneurysmal disease, found the prevalence of AAAs to be 13.5%.[27]

In conclusion, the majority of AAAs are asymptomatic and opportunitistic detection is the most common way in which they are discovered. Despite technological advancement, clinical examination still plays a paramount role in the detection of AAAs. Nevertheless, it may miss up to a third of palpable aneurysms if one does not consider this as a possible diagnosis, or fail to direct the examination specifically towards AAA detection. A systematic abdominal examination and a high index of suspicion, especially in the "high risk" population, would improve detection of AAAs.

References

1 Collin J, Araujo L, Walton J, Lindsell D. Oxford screening programme for abdominal aortic aneurysm in men aged 65 to 74 years. *Lancet* 1988; **ii**: 613–615.

2 Government Statistical Service. Hospital episode statistics. Volume 1. Finished consultant episodes by diagnosis, operation and speciality. England: financial year 1992–93. London: HMSO, 1995.

3 Greenhalgh RM. Prognosis of abdominal aortic aneurysm. *Br Med J* 1990; **301**: 136.

4 Vital statistics of the United States 1990. U.S. Department of the Health and Human Services, Public Health Service. Vol II, Part A; 228.

5 Katz DJ, Stanley JC, Zelenock GB. Operative mortality rates for intact and ruptured abdominal aortic aneurysms in Michigan: an eleven-year statewide experience. *J Vasc Surg* 1994; **19**: 804–817.

6 Mannick JA, Whittemore AD. Management of ruptured or symptomatic abdominal aortic aneurysms. *Surg Clin North Am* 1988; **68**: 377–384.

7 Ingoldby CJ, Wujanto R, Mitchell JE. Impact of vascular surgery on community mortality from ruptured aortic aneurysms. *Br J Surg* 1986; **73**: 551–553.

8 Nevitt MP, Ballard DJ, Hallet JW Jr. Prognosis of abdominal aortic aneurysms. *N Engl J Med* 1989; **321**: 1009–1014.

9 Bickerstaff LK, Hollier LH, Van Peenen HJ *et al.* Abdominal aortic aneurysms: The changing natural history. *J Vasc Surg* 1984; **1**: 6–12.

10 Johnstone KW, Rutherford RB, Tilson MD *et al.* Suggested standards for reporting on arterial aneurysms. *J Vasc Surg* 1991; **13**: 444–450.

11 Collin J. A proposal for a precise definition of abdominal aortic aneurysm. *J Cardiovasc Surg* 1990; **31**: 168–170.

12 Moher D, Cole CW, Hill GB. Epidemiology of abdominal aortic aneurysm: the effect of differing definitions. *Eur J Vasc Surg* 1992; **6**: 647–650.

13 Cronenwett JL, Murphy TF, Zelenock GB *et al.* Actuarial

analysis of variables associated with rupture of small abdominal aortic aneurysms. *Sugery* 1985; **98**: 472–483.
14 MacSweeney STR, O'Meara M, Alexander C *et al.* High prevalence of unsuspected abdominal aortic aneurysm in patients with confirmed symptomatic peripheral or cerebral arterial disease. *Br J Surg* 1993; **80**: 582–584.
15 Lederle FA, Walker JM, Reinke DB. Selective screening for abdominal aortic aneurysms with physical examination and ultrasound. *Arch Int Med* 1988; **148**: 1753–1756.
16 Kiev J, Eckhardt A, Kerstein MD. Reliability and accuracy of physical examination in detection of abdominal aortic aneurysms. *Vasc Surg* 1997; **31**: 143–146.
17 Allardice JT, Allwright GJ, Wafula JM, Wyatt AP. High prevalence of abdominal aortic aneurysm in men with peripheral vascular disease: screening by ultrasonography. *Br J Surg* 1988; **75**: 240–242.
18 Graham M, Chan A. Ultrasound screening for clinically occult abdominal aortic aneurysm. *Can Med Assoc J* 1988; **138**: 627–629.
19 Allen PI. Screening for abdominal aortic aneurysm. *Biomed Pharmacother* 1988; **42**: 451–454.
20 Ohman EM, Fitzsimons P, Butler F, Bouchier-Hayes D. The value of ultrasonography in the screening for abdominal aortic aneurysm. *Ir Med J* 1985; **78**: 127–129.
21 Chervu A, Clagett PG, Valentine JR, Myers SI, Rossi PJ. Role of physical examination in detection of abdominal aortic aneurysms. *Surgery* 1995; **117**: 454–457.
22 Arnell TD, De Virgilio C, Donayre C *et al.* Abdominal aortic aneurysm screening in elderly males with atherosclerosis: the value of physical exam. *Am Surg* 1996; **62**: 861–864.
23 Twomey M, Twomey E, Wilikins RA, Lewis JD. Unrecognised aneurysmal disease in male hypertensive patients. *Int Angiol* 1986; **5**: 270–273.
24 Karanjia PN, Madden KP, Lobner S. Coexistence of abdominal aortic aneurysm in patients with carotid stenosis. *Stroke* 1994; **25**: 627–630.
25 Wolf YG, Otis SM, Schwend RB, Bernstein EF. Screening for abdominal aortic aneurysms during lower extremity arterial evaluation in the vascular laboratory. *J Vasc Surg* 1995; **22**: 417–423.
26 Lehnert B, Wadouh F. High coincidence of inguinal hernias and abdominal aortic aneurysms. *Ann Vasc Surg* 1992; **6**: 134–137.
27 Fowl RJ, Blebea J, Stallion A *et al.* Prevalence of unsuspected abdominal aortic aneurysms in male veterans. *Ann Vasc Surg* 1993; **7**: 117–121.
28 Baird DA, Sandovnick AD, Yee IM *et al.* Sibling risks of abdominal aortic aneurysms. *Lancet* 1995; **346**: 601–604.
29 Tan K, Stansby G. The management of popliteal artery aneurysms. *Vasc Disease* 1998; **1**: 98–104.
30 Vardulaki KA, Prevost TC, Walker NM *et al.* Growth rates and risk of rupture of abdominal aortic aneurysms. *Br J Surg* 1998; **85**: 1674–1680.
31 Derbyshire NDJ, Lindsell DRM, Collin J, Creasy TS. Opportunistic screening for abdominal aortic aneurysm. *J Med Screening* 1994; **1**: 220–222.

Accepted 18 October 1999