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Screening for abdominal aortic aneurysm in the Jeddah area, western Saudi Arabia

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Atherosclerosis and its complications are associated with high morbidity and mortality in the elderly. One of these complications is abdominal aortic aneurysm which may be prevented from rupturing if diagnosed early. Screening for aortic aneurysm was carried out in Jeddah, which is in the western region of Saudi Arabia, to identify the magnitude of this problem. Three groups were studied: patients with hypertension ($n = 101$), patients with peripheral vascular disease ($n = 71$) and a third group of controls ($n = 220$). The mean (range) age of the whole sample was 66.0 (60–80) years. Evidence of aortic aneurysm was found in seven participants: five in the peripheral vascular disease group (7.0%), one in the hypertensive group (1.0%) and one in the controls (0.5%). In view of the expected increase in the elderly population of Saudi Arabia, as a result of improvements in health care which have recently been achieved, it is expected that a similar increase in the incidence of abdominal aortic aneurysm may occur. Routine screening for abdominal aortic aneurysm in the elderly, especially in those with peripheral vascular disease, may be worthwhile.

Keywords: aorta, aneurysm, atherosclerosis

In Saudi Arabia the size of the elderly population is expected to increase in the near future as a result of improvements in health care. Furthermore, a change in life style and nutrition, which is becoming similar to a Western one, is already evident. Theoretically, these factors should lead to an increase in the numbers of patients with atherosclerosis and its complications. This includes abdominal aortic aneurysm.

The abdominal aorta is the most common site for aneurysm to develop[1]. From autopsy studies[1] the prevalence of abdominal aneurysm in the population has been estimated at 2%. A similar prevalence was reported by Collin *et al.*[2] in men aged 65–74 years in the Oxford area of the UK. A slightly higher prevalence (2.7%) was reported by Scott and colleagues[3] from Chichester in the UK. There have been at least two other recent surveys carried out in the UK[2–6]. Their results are not strictly comparable because of the differing populations, definitions of disease and use of ultrasonography; however, the overall prevalence was of a similar magnitude. The incidence of ruptured abdominal aortic aneurysm (newly diagnosed cases) is steadily increasing; rising from 9.2 per 100,000 in 1979 to 17.5 per 100,000 in 1986 in England[7]. In Scotland, admission of patients over 55 years of age with an abdominal aortic aneurysm increased from 25.8 per 100,000 in 1971 to 63.6 per 100,000 in 1984[8]. Similar changes were also noted in the USA and Australia[9,10]. It was also shown that the prevalence of abdominal aortic aneurysm increases in selected groups of elderly people. Allen *et al.*[11] found that the prevalence was about 12% in a group of elderly patients in hypertension. Prevalence in another group suffering from peripheral vascular disease was about 11%[5]; these patients were the first-degree relatives of patients with aortic aneurysm[12,13].

To the best of the authors' knowledge no data are available about the prevalence of aneurysm in the Jeddah area of Saudi Arabia[14]. This report should provide useful information to the world medical literature in the understanding of the epidemiology of abdominal aortic aneurysm. Certainly, a knowledge of the prevalence of any diseae, including aortic aneurysm, will help in the planning and organization of health services.

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There are many sources of data on the prevalence of abdominal aortic aneurysm, such as autopsy studies[15], hospital admissions[8] and mortality statistics[16,17]. However, each of these has its own limitations and indeed underestimates the true prevalence of the disease. Diagnostic ultrasonography and computed tomography (CT) were used as valid and reliable tools in studying the prevalence of abdominal aortic aneurysm. Despite its few limitations, ultrasound is considered the best method of screening for aortic aneurysm in many series[2,3,10,18,19].

Patients and methods

Over a period of 18 months starting on 12 July 1991, patients from the Jeddah area were recruited. Jeddah is one of the largest cosmopolitan cities in western Saudi Arabia and its population consists of a multiracial people. Patients were recruited consecutively, irrespective of sex or ethnic origin, according to the following categorization: the first group comprised patients with hypertension ($n = 101$) with a diastolic pressure of 90 mmHg or more measured at two readings. Most were attending the hypertension primary health care centre or hypertension medical clinic; the second group was aged 60–80 years with evidence of peripheral vascular disease involving the lower limbs ($n = 71$). They were recruited consecutively when attending the principal investigator's outpatient clinic; the third group included participants of the same age who had no evidence of peripheral vascular disease or hypertension who were attending the same primary health care centre or accompanying their relatives to hospital ($n = 220$). The various groups were recruited according to the previous definitions.

All participants were interviewed by the principal investigator (H.Z.) or one of his trained qualified surgical registrars. The personal data of the candidate, possible risk factors including smoking, manifestations of peripheral vascular disease, myocardial or respiratory medical history, height and weight, and systolic/diastolic blood pressure were recorded. Full vascular assessment was performed and resting ankle/brachial ratio was measured (a ratio of less than 0.9 was considered abnormal).

Attention was then directed at palpating the aorta by the same examiner (H.Z.). This was performed in the supine position using two techniques. First, the flat of the hand is pressed against the vertebral column in the supine position for 10 s. Second, the index finger is pressed into the abdomen 3 cm below the umbilicus. If a pulse is detected then the diameter is defined by the tips of the fingers[19].

Evidence of aortic calcification was examined on plain abdominal films of all participants. Abdominal ultrasonography was then performed using a sonoline ultrasound machine with 3.5- and 5-mHz probes. The course of the infrarenal abdominal aorta was imaged fully to bifurcation in the longitudinal and transverse planes. Three measurements were usually attempted at the following levels: suprarenal, mid-aorta and just above the bifurcation. Whenever possible these were performed by the consultant radiologist. An aorta with an external diameter of 3.2 cm or more was considered aneurysmal. An aorta of 2.0–3.2 cm in diameter was considered ectatic. Abdominal CT with and without intravenous contrast was usually conducted once a provisional diagnosis of abdominal aortic aneurysm was made. The contrast examination was obtained in dynamic mode (CT angiogram). Arteriography was carried out on patients with peripheral vascular disease or when surgical intervention to repair the aortic aneurysm was considered.

All data was entered onto a computer. D-Base IV (USA) was used for this purpose. The Statistical Package for Social Sciences (SPSS) (USA) was used to clean the data and generate descriptive statistics such as demographic data, χ^2 test and Fisher's exact test which compared the proportion of abdominal aortic aneurysm, among the three groups. Two sample t-tests were used to assess the difference in the means between the groups.

Results

A total of 392 candidates were recruited over a period of 18 months in the Jeddah area. There were 278 (70.9%) males and 114 (29.1%) females. The mean (s.d.) (range) age of the group was 66.0(6.3) (60–80)years. One-third was above 70 years of age. Diabetes mellitus was a common risk factor in the whole sample, 172 (43.9%) being known diabetics. However, only 116 (29.6%) had hypertension. Interestingly, 259 (66.1%) were non-smokers. The percentage of active smokers was 21.2% and that of ex-smokers 12.8%.

In the whole sample, it was not possible to measure the aortic diameter at the suprarenal level in five patients (1.3%) as well as in 10.5% and 14.0% of diameters at the mid-aorta and bifurcation respectively. However, the mean (s.d.) of the three measurements obtained at the various levels (excluding ectatic and aneurysmal aortas) was 1.80(0.26) cm. According to the authors' definition of ectasia (aortic diameter of 2.0–3.2 cm), nine cases (2.3%) were found in the whole sample. These were distributed throughout the various groups (*Table 1*). The difference in prevalence of ectasia between the three groups was not significant.

Clinical examination of the abdomen gave rise to a positive impression for abdominal aortic aneurysm in eight patients (2.0%), uncertainity in 27 (8.9%), and negative in 357 (91.1%). However, the positive predictive value was only 37.5%, indicating the low accuracy rate of the clinical examination. Sensitivity of abdominal examination was 42% and specificity 98%. Plain abdominal radiography showed calcification in 109 patients (27.8%) in the whole sample. However

Table 1 Prevalence of ectasia and abdominal aortic aneurysm in the various groups

	Ectasia (%)	Abdominal aortic aneurysm (%)
Whole sample	2.3	1.8
Controls	1.9	0.5
Patients with hypertension	2.6	1.0
Patients with peripheral vascular disease	5.9	7.0

only four (37.1%) of seven abdominal aortic aneurysms had evidence of calcification on plain film. The association between radiographic findings (calcification) and ultrasonography was not significant, indicating its limited value in screening for aortic aneurysm.

In the whole sample, seven cases of abdominal aortic aneurysm were detected and confirmed by abdominal ultrasonography, giving a prevalence of 1.8%. These seven cases were distributed throughout the groups, with the highest frequency in those with peripheral vascular disease ($n = 5$). Three cases were successfully repaired. The difference in the prevalence of aortic aneurysm between the controls and patients with hypertension was not significant, while that between the controls and those with peripheral vasular disease was significant (χ^2 8.5, d.f. = 1, $P = 0.0035$).

Discussion

Abdominal aortic aneurysm is common in Western countries. For instance aortic aneurysm is the 13th cause of death and is responsible for 15,000 deaths per year in the USA[20]. The incidence of symptomatic abdominal aortic aneurysm has also increased by greater than twofold[10]. Similar changes have also been noted in England, Scotland and Australia[8,9,11]. Age has a dramatic effect on the incidence of abdominal aortic aneurysm. In Rochester, USA, incidence was essentially zero in individuals below the age of 49 years, increasing from 2.1 in the 40–49 year age group to 2.83 in those over 80 years of age[21]. Recently, Morris *et al.*[6] advocated screening all men over the age of 50 years and described it as a cost-effective method, offering greater potential benefits than screening the elderly. There is good evidence that this increase in incidence is related mainly to aging of any population as well as improvements in diagnostic procedures. These two factors are applicable to a country such as Saudi Arabia which is witnessing a steady increase in its geriatric population as a result of improvements in health services. The authors' theory for screening for abdominal aortic aneurysm was based mainly on this assumption. In addition, the life style and dietary habits have changed significantly to a Western one over the past two decades.

In designing the present study, the authors' selected the 60–80 year age group as a target population for the following reasons. Firstly, abdominal aortic aneurysm is a disease of old age and an elderly group should be selected to achieve a satisfactory detection rate. Second, aortic aneurysms in patients older than 80 years may not be suitable for surgical repair as such patients will be too old to accept or benefit from treatment. Nevertheless, two patients of the detected seven cases were considered unfit and a third one refused to have surgical treatment and discharged himself against medical advice.

In previous studies[2,4,6,22,23], only men were screened under the assumption that they are at higher risk. However, in the present study men and women were screened. This policy was adopted for two reasons. First, this series is the first of its kind in the literature from the Middle East and thus there were no previous studies on which to base a selection criteria. Second, prevalence in white and black Americans is known to differ: that is white males of 4.2% appeared to exceed the prevalence in white females in contrast to black males and females who had the same prevalence (1.5%)[24]. In the present sample males formed 70.9% of the white sample. However, three of the seven aneurysms detected occurred in females. This may indicate a different pattern from that mentioned in the British studies which recommended selective screening of only males.

Abdominal aortic aneurysm is known to be more common in patients with hypertension[4,15,25], patients who have symptoms of occlusive arterial disease[5,26–28], first-order relatives (parent, siblings, offspring) of patients with abdominal aortic aneurysm[12,13,29,30] and smokers[31]. This first two groups of patients were studied for obvious reasons mentioned previously. However, relatives of patients with abdominal aortic aneurysm were not included to avoid bias. Certainly, a different type of study is needed to determine prevalence in relatives of patients with aortic aneurysm. Finally, from the autopsy studies it was found that abdominal aortic aneurysm was eight times more common among smokers than non-smokers. To the best of the authors' knowledge, no one has designed abdominal aortic aneurysm screening for smokers and current judgemental attitudes to this human weakness make it unlikely that such a project would be well received[22]. Interestingly, smoking is not a great problem in Saudi Arabia as only 29.9% of the population are active smokers. This is a very low percentage compared with those cited in other studies in the literature. In contrast, diabetes was fairly common (56.1%; however, this condition is associated more with peripheral occlusive disease.

Although careful abdominal examination will identify most large aneurysms, small aneurysms are very difficult to detect, particularly in obese patients[32]. Moreover, false-positive examinations may result if the abdominal aorta is tortuous or in the presence of

an abdominal mass. In the study described here, as the abdominal examinations were carried out by qualified surgeons, the clinical impression was correct in three of the seven confirmed cases of aortic aneurysm with low sensitivity of 42%, which indicates a low detection rate if clinical examination alone is relied on. It is apparent that a high predictive value is desirable. Thus, clinical examination will lead to essentially unproductive diagnostic work-up. The predictive value of a positive test is of great importance to the practising physician, who must interpret positive test results and counsel patients about a course of action. Therefore, ultrasonographic examination is the preferred method of screening for abdominal aortic aneurysm. Epidemiological autopsy as a research tool for estimating the reservoir of aortic aneurysm in the population has also been described[33]. However, this method is biased and not applicable to Saudi Arabia where post-mortem examination is carried out very selectively.

In view of the low accuracy rate of the previous three methods, B-mode ultrasonography was described as the tool of choice in screening for abdominal aortic aneurysm[34,35]. It is safe, reproducible and has a high degree of accuracy (approaching 100%)[5,27,35]. Although CT also possess the same advantages, ultrasonography has the additional benefit of not requiring contrast medium, not using ionizing radiation and is less expensive[36].

Prevalence of abdominal aortic aneurysm in the present is compared with that of similar studies in *Tables 2–4*. Overall, it is very difficult and perhaps unscientific to compare the various reports in the literature because of the wide disparate selection criteria and lack of uniformity in the diagnostic criteria for aortic aneurysm. Nevertheless, the prevalence of aortic aneurysm in the third group (i.e. healthy individuals) was significantly lower than in similar studies in the literature. This may be attributed to genetic factors and the low incidence of smoking in Saudi Arabia (*Table 2*). Prevalence of aortic aneurysm in patients with hypertension was 1.0%. This again is significantly lower than most of the series in the literature except for the Swedish series of Lindholm *et al.*[25] (*Table 3*). The highest prevalence of aortic aneurysm, namely 7.0%, was found in patients with peripheral vascular disease and compares favourably with 6–14% reported in other studies (*Table 4*). Certainly, this group of patients deserves screening in view of this high prevalence.

Table 2 Screening studies for abdominal aortic aneurysm in healthy individuals (i.e. low risk groups in the present study)

Reference	Country	No. of patients screened	Prevalence of abdominal aortic aneurysm (%)	Notes
Collin *et al.*[2]	Oxford, UK	426	5.4	Males only
Scott *et al.*[34]	Chichester, UK	1312	5.8	—
Al Zahrani *et al.*	Jeddah, Saudi Arabia	220	0.5	—

Table 3 Screening studies for abdominal aortic aneurysm in patients with hypertension

Reference	Country	No. of patients screened	Prevalence of abdominal aortic aneurysm (%)	Notes
Allen *et al*[4]	Birmingham, UK	94	7.4	Males only
	Birmingham, UK	71	2.8	Females only
Lindholm *et al.*[25]	Lund, Sweden	245	0.4	—
Twomey *et al.*[23]	Harrow, UK	200	7.0	Males only
Al Zahrani *et al.*	Jeddah, Saudi Arabia	101	1.0	—

Table 4 Screening studies for abdominal aortic aneurysm in patients with peripheral vascular disease

Reference	Country	No. of patients screened	Prevalence of abdominal aortic aneurysm (%)	Notes
Allardice *et al.*[7]	London, UK	90	11.1	—
Gallard *et al.*[26]	Reading, UK	242	14.0	—
Reid *et al.*[27]	Glasgow, UK	100	6.0	—
Cabellon *et al.*[28]	USA	73	9.6	—
Al Zahrani *et al.*	Jeddah, Saudi Arabia	71	7.0	—

A population screening programme for abdominal aortic aneurysm has been described in several reports[4,34]. However, before embarking on a major population screening programme for aortic aneurysm the following points should be considered. The disease is not yet common in Saudi Arabia — 0.5% in relatively healthy people and 1% in patients with hypertension. Undoubtedly, screening of all patients with peripheral vascular disease is highly recommended; no additional cost would be incurred if the ultrasound vascular duplex probe was merely swept across the abdomen, as most of these patients are managed in vascular units with equipped vascular laboratories. For the other high-risk groups and also the elderly in Saudi Arabia, where ultrasound and even computed tomography machines are widely available, it may be worthwhile encouraging radiologists to look for abdominal aortic aneurysm routinely when performing these tests on elderly patients, particularly hospitalized patients[37,38]. The screening costs of such a selective programme are negligible. Nevertheless, the trade-off to this restricted approach is the many potentially fatal aneurysms not detected in the general population. O'Kelly and Heather[39] recommended a general practice-based screening programme, with examination taking place on surgery premises and performed by an unsupervised radiographer. They describe this method of cost containment as attractive and efficient. The present authors' think that such a programme may be applied within the next few years, following maturation of the general practice health sector.

In view of the present results, the authors recommend screening of the elderly population aged 60–80 years in Saudi Arabia and particularly those suffering from peripheral vascular disease. Screening should be done whenever possible in primary health care centres and obviously in hospitals. To make it cost-effective, ultrasonography can be performed by a well trained nurse using a portable ultrasound machine.

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