

Original Article

Ultrasonographic Screening for Abdominal Aortic Aneurysms in Iranian Candidates for Coronary Artery Bypass Graft Surgery

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Background: To evaluate the prevalence of abdominal aortic aneurysm in Iranian candidates for coronary artery bypass graft surgery and its associated factors.

Methods: Totally, 2843 consecutive candidates for coronary artery bypass graft surgery underwent ultrasonography of abdominal aorta. The relation between abdominal aortic aneurysm with gender, age, smoking, dyslipidemia, hypertension, diabetes, and carotid and coronary stenosis was evaluated.

Results: The prevalence of abdominal aortic aneurysm was 2.7% and 0.7% in men and women subgroups, respectively. The prevalence was 3.8% in men older than 65 years. The largest diameter of abdominal aortic aneurysm was 61.7 mm. Only two men had aneurysm larger than 55 mm, which led to changing their surgery schedule to stenting. Gender, age, smoking, smoking more than 40 years, diabetes, hypertension, and significant carotid stenosis were associated factors of abdominal aortic aneurysm.

Conclusion: Compared with the results cited in Western studies, the prevalence of abdominal aortic aneurysm is lower in Iran ($P < 0.0001$). Its associated factors in our study were similar to previously published studies. Significant carotid stenosis, a factor not reported previously, was an associated factor in our study. Because of the low prevalence of abdominal aortic aneurysm in our population, screening the candidates for coronary artery bypass graft surgery is not recommended.

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Introduction

The prevalence of abdominal aortic aneurysms is increasing because of increased life expectancy.^{1,2} There are none or few symptoms related to abdominal aortic aneurysm until rupture. After rupture, mortality rates are 60 – 80%, but with an elective operation,

the mortality will be 3 – 7%. Rupture of abdominal aortic aneurysm accounts for about 1% of all deaths in Western countries.³ Regarding these facts, screening for abdominal aortic aneurysm has been discussed in the literature for nearly 40 years.⁴ Patients with coronary artery disease have common risk factors with patients having abdominal aortic aneurysm; therefore, candidates for coronary artery bypass graft (CABG) surgery have been a target group for screening abdominal aneurysm in many Western studies.^{5,6,7} Having considered that the prevalence of abdominal aortic aneurysm differs in different ethnic groups,² we designed this study to evaluate such aneurysms in a group of Iranian candidates for CABG. We set up this study to determine the prevalence of abdominal aortic aneurysm, its risk factors, and its impact on CABG.

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Materials and Methods

In a cross-sectional study from July 2005 through August 2006, gray scale abdominal aortic ultrasonography was performed on all elective candidates for CABG (n=2843) in Tehran Heart Center (a referral hospital for cardiovascular care, affiliated to Tehran University of Medical Sciences), Tehran, Iran.

Abdominal ultrasonography was done by an expert radiologist who had been practising abdominal ultrasonography on a daily basis for more than seven years. The patients were examined in supine position and we did not use any bowel preparation. No instruction on food or fluid intake was given before the examinations. The ultrasonographic evaluation was done with LOGIQ 5 EXPERT (The Horizon Release, GE Medical System, the United States) with linear 10 MHz and curvilinear 3.5 MHz transducers.

The abdominal aorta was first visualized in the longitudinal plane and was examined from diaphragm to the bifurcation. It was then examined in axial plane with scans perpendicular to the longitudinal plane. The maximum external aortic diameter was measured with electronic calipers in each patient. Transverse diameter more than 25 mm was considered abnormal according to Emerton et al.,⁸ and Calderwood and Welch.⁹ Color Doppler ultrasonography of the carotid arteries was performed for all the patients at the same time. We used Nicolaides criteria,¹⁰ to define the grade of carotid stenosis, similar to our previous study.¹¹

All patients had a lipid profile [(triglyceride, cholesterol, low-density lipoprotein (LDL), and high-density lipoprotein (HDL)] preoperatively. Serum cholesterol and triglyceride levels were measured by enzymatic methods, HDL by direct method, and LDL by Friedewald's method. Diabetes was defined as blood sugar >6.6 mmol/L on two separate examinations or a history of taking antihyperglycemic drugs. All the laboratory measurements were done within 24 hours of abdominal ultrasonography. The smoking status of

the patients was determined. The patients were classified as active smokers, nonsmokers (never smokers or history of smoking which had been quitted more than five years ago), and ex-smokers (previous smokers who had quitted smoking since five years ago). Pack-years were calculated as the number of cigarettes smoked per day multiplied by the duration of smoking (years) divided by 20. The results of coronary angiography (degree of the left main coronary stenosis, and number of diseased coronary arteries) were extracted from the hospital data bank.

This study was approved by the ethics committee of the hospital.

Statistical methods

For continuous variables, the values are expressed as mean±standard deviation. For discrete variables, values are expressed as percentages. For continuous variables, *t*-test was used to access the difference between the two groups and for qualitative variables, Chi-square test was used. For small sizes, we used Fisher's exact test. A *P* value of <0.05 was considered significant.

At the second step, we assessed the association between abdominal aortic aneurysm and the important variables (gender, age >65 years, smoking status, hypertension, diabetes, carotid stenosis, number of diseased vessels, and the left main trunk involvement >50%) in a multivariate regression. We put all the mentioned variables in a multivariate logistic regression, which was considered the presence of abdominal aortic aneurysm as the dependent variable. All statistical analyses were performed using SPSS Software Version 13.

Results

Of the 2843 consecutive candidates for elective CABG without a history of previous aortic surgery or intervention, 24 (0.8%) patients were excluded because of gassy bowel, which is an obstacle for evaluation of the aorta. There were no other exclusion criteria. The remaining 2819 patients

Table 1. Mean age and frequency of abdominal aortic aneurysm in both genders.

	Gender (%)	Age	<i>P</i> value	OR	Number of AAA cases
Men	1963 (69.6%)	61±9.2	0.001	3.93	53(2.7%)
Women	856 (30.4%)	62±8	>0.2	—	6(0.7%)

OR=odds ratio; AAA=aneurysm of abdominal aorta.

included 1963 men (69.6%) and 856 women (30.4%). The mean age was 61.0±9.2 years for men and 62.0±8.0 years for women.

Overall, 59 patients (2.09%) comprising of 53 men and six women had abdominal aortic aneurysm, which showed a significant sex difference ($P=0.001$, $OR=3.93$, Table 1). The largest aneurysm in our study was 61.7 mm (mean: 30.70±7.01 mm).

Because of the low frequency of abdominal aortic aneurysm in women, they were excluded from the analysis like many other studies. We also excluded three other patients because of missed data. Of the 1960 men, 658 (33.5%) were older than 65 years, and 1302 (66.3%) were 65 or less.

We detected that the frequency of abdominal aortic aneurysm in patients aged 65 years and more was significantly more than our younger patients ($P=0.03$, $OR=1.79$). Furthermore, we found out that abdominal aortic aneurysm was notably more in the smoker patients (4.6% versus 1.8%, $P=0.0001$, $OR=1.63$).

At the second step, we decided to determine whether longer years of smoking affect the prevalence of abdominal aortic aneurysm in the smokers. We found that 8.6% of the patients with a history of smoking for ≥40 years had the disease, and the rate of aneurysm was 2.6% ($P=0.0001$, $OR=3.49$).

Among the smoker and ex-smoker patients, the rate of pack-year smoking was 33.8±21.4 in patients with aneurysm and 27.4±20.3 in patients without aneurysm ($P=0.090$).

The frequency of abdominal aortic aneurysm was significantly more in diabetic patients compared with nondiabetic ones (3.2% versus 1.4%, $P=0.033$, $OR=2.32$).

In hypertensive patients, the rate of aneurysm was significantly higher compared with the normotensive patients (4.1% versus 2.2%, $P=0.030$, $OR=1.85$).

Sixty-six percent of the patients with aneurysm had desirable serum triglyceride concentration while 66.5% had high triglyceride (≥2.6 mmol/L, $P=0.94$). Regarding serum HDL levels, the patients were categorized into three groups: high risk, moderate risk, and low risk (HDL<1.20, 1.20 – 1.39, ≥1.40 mmol/L, respectively). The frequency of aneurysm was 2.9%, 3.1%, and 1.9% in the mentioned groups, respectively ($P=0.73$).

The patients were classified, regarding the serum LDL levels, into low risk (less than 3.37 mmol/L), moderate risk (3.37 to 4.12 mmol/L),

and high risk (more than 4.14 mmol/L) groups. The frequency of abdominal aortic aneurysm was 2.8%, 3.6%, and 2.6% in the mentioned groups, respectively ($P=0.76$).

Low-risk, moderate-risk, and high-risk groups for serum cholesterol levels were defined as serum levels less than 5.18 mmol/L, 5.18 to 6.19 mmol/L, and more than 6.22 mmol/L, respectively. The frequency of abdominal aortic aneurysm was 2.7%, 2.7%, and 3.6% in the mentioned groups, respectively ($P=0.77$).

Regarding carotid Doppler study, we classified the patients into three groups: normal carotid or stenosis under 50% in each side, at least 50 – 69% stenosis in one side, and at least >70% stenosis in one side. The frequency of abdominal aortic aneurysm was 2.3%, 10%, and 6.1% in the mentioned groups, respectively ($P=0.0001$, $OR=4.72$). The frequency of aneurysm was 10.8% in the patients older than 65 years with carotid stenosis more than 50%.

Five point three percent of the patients with single vessel disease, 1.9% of the patients with two vessels disease, and 2.5% of the patients with three vessels disease suffered from abdominal aortic aneurysm simultaneously ($P=0.33$). Also, 1.8% of the patients with the left main coronary stenosis of >50% had aneurysm while this figure was 2.6% in the patients without the left main stenosis of >50% (Table 2).

Discussion

Abdominal aortic aneurysm is the 15th leading cause of death in the United States. It remains asymptomatic for many years and ultimately ruptures in one third of patients. The mortality is up to 80% after the rupture. Repair of the aneurysm before its rupture is accompanied by a very low operative mortality rate, about 5%.⁴

All the mentioned facts and the fact that the incidence of abdominal aortic aneurysm is increasing have stimulated physicians to screen for the disease. Schilling did the first screening of abdominal aortic aneurysm in 1964 by lateral abdominal radiography.¹² Today, abdominal ultrasonography is the best tool to screen for abdominal aortic aneurysm.⁴

The prevalence of abdominal aortic aneurysm has been different in various studies. The first reason is the fact that different definitions of aneurysm have been used by different authors. Some authors have considered aorta "aneurysmal"

Table 2. Results of multivariate regression analyses between important variables and presence of abdominal aortic aneurysm.

	Percentage	P value	OR
Sex	—	0.011	3.29
Age ≥65	3.8%	0.003	1.79
Smoking ≥40 years	8.6%	0.0001	3.49
Smoking	4.6%	0.0001	1.63
Hypertension	4.1%	0.026	1.85
Diabetes	3.2%	0.017	2.32
Carotid stenosis 50 – 70%	10%	0.0001	4.72
Patients with three coronary vessels involvement	2.5%	0.33	—
Left main lesion >50%	1.8%	0.2	—

OR=odds ratio

when its diameter reaches 30 mm.^{4,13,14} Some others have considered diameter more than 25 mm as aneurysm.^{8,9} Morris et al. have defined aorta "aneurysmal" when infrarenal aortic diameter reaches 30 mm or more in patients aged 65 years or more and 25 mm or more in patients younger than 65.¹⁵

Because of the low prevalence of abdominal aortic aneurysm in our population, we chose "25 mm" as the cut-off point to increase the sensitivity of our study.

The study population is another factor affecting the prevalence of abdominal aortic aneurysm. Some studies have only included patients with cardiovascular risk factors,^{1,9} while other studies have evaluated elderly men.^{16,14,17} Singh et al. studied 6386 men and women inhabitants of the Tromso, Norway aged 25 – 84 years without considering the risk factors.³ At least one study has proved that ethnicity affects abdominal aortic aneurysm (northern European versus Mediterranean).²

Clear gender difference reported in the literature,^{1,3,17,18} with a four- to six-time greater risk in men. In our study, the difference was 3.8, very similar to other studies.⁸ The gender difference has been related to inhibition of matrix metalloproteinase 9 (MMP-9) productions by the macrophages mediated by circulating estrogen in women.¹⁸

Age 65 years has been proposed suitable for aneurysm screening because future death from aneurysmal rupture is rare after a negative screening at this age.⁴ In our study, the aneurysm

was 1.7 times more prevalent in patients older than 65 years. Compared with Lederle's⁴ report, the number of abdominal aortic aneurysm in male patients aged 65 years and over was lower in our study (Table 3).

Abdominal aortic aneurysm occurs in one of 20 elder men in European and North American countries. In Valdes et al's study, the prevalence of aneurysm was 7.6% in elder men with cardiovascular risk factors (smoking, hypertension, occlusive arterial disease) in Chile. The mean diameter of aneurysm was 4.1 cm in that study.¹ This prevalence was 15.3% in patients in the waiting list for CABG in the UK.¹⁰

The overall prevalence of 2.09% in our study is lower than cardiac patients of the European studies ($P<0.0001$).¹⁰

A population-based study in eastern Australia confirmed that risk of abdominal aortic aneurysm was higher in men with northern European origin compared with those of Mediterranean origin.² The lower rate of abdominal aortic aneurysm in our study is compatible with lower risks in the Mediterranean region.

Not only is the prevalence of abdominal aortic aneurysm lower in our study, but its mean diameter is lower than similar studies ($P<0.0001$) as well.¹ There is no indication for operating on abdominal aortic aneurysm or interventional repair until its diameter reaches 55 mm.¹⁹ There were only two elderly men in our study suffering from the aneurysm larger than 55 mm (prevalence: 0.3%). Their aneurysms were repaired by stenting before CABG.

Table 3. Comparison of the prevalence of abdominal aortic aneurysm in men aged ≥65 years.

Study	Current smoker (n)	% of AAA in smokers	Never smoked (n)	% of AAA in never smoked
Lederle (ADAM study)	22639	6.3	30033	1.6
THC	491	5.5	1119	1.9

ADAM=aneurysm detection and management study screening program; THC=Tehran Heart Center; AAA=abdominal aortic aneurysm

Smoking increases the risk of abdominal aortic aneurysm three to five times in Western population.²⁰ In our study, smoking was a risk factor for aneurysm but with less influence (Table 2). Duration of smoking (as years) and pack per year are two measurable parameters in evaluating smoking habits. In our study, the duration of smoking influenced the prevalence of abdominal aortic aneurysm. In Singh et al's study,³ smoking had strong association with the risk of aneurysm, but the duration of smoking, not the number of cigarettes smoked per year, had association with risk of the aneurysm. When we compared the non-smokers with smokers (with smoking duration >40 years), the multivariate-adjusted odds ratio (OR) for abdominal aortic aneurysm increased from 1.4 to 8.0 (95%CI: 5.0, 12.6).

Absence of diabetes was a risk factor for abdominal aortic aneurysm in our study as in other studies.⁴

Singh et al suggested a strong correlation between serum HDL level and abdominal aortic aneurysm, but there was no relation with triglyceride.³ We found no correlation between serum triglyceride and HDL levels, and abdominal aortic aneurysm. The patients with dyslipidemia in our study had been taking medication because they were referred from the cardiology clinic. Therefore, the results did not really reflect the patients' status. The stress of future cardiac surgery increases sympathetic drive in patients, and sympathetic stimulation is a well-known factor for temporary reduction of blood lipids.

When examining the correlation between abdominal aortic aneurysm and atherosclerosis of the other arteries, we noted a strong relation between the aneurysm and atherosclerosis of carotid arteries (categorized as degree of stenosis), while there was no relation with abdominal aortic aneurysm and coronary atherosclerosis (either number of diseased vessel or degree of stenosis of the left main coronary artery). Both abdominal aorta and carotid arteries are categorized as large vessels, while coronary arteries are medium-sized vessels. So, coincidence of abdominal aortic aneurysm and atherosclerosis of carotid arteries is not surprising. To the best of our knowledge there is no large study correlating abdominal aortic aneurysm and carotid stenosis. And there is only one report of abdominal aortic aneurysm from Turkey,¹³ which determined the prevalence of abdominal aortic aneurysm in "a mixed Turkish population, who were undergoing abdominal

ultrasonographic examination for pathologies not involving aorta". The prevalence of abdominal aortic aneurysm was 0.6% in that study and the mean age was 48 years.

Our study had some limitations. We excluded 24 patients from the study because of gassy bowel. It was a trivial (0.8%) number of patients who could be re-evaluated after bowel preparation. Another limitation was that we did not evaluate some other known risk factors such as peripheral vascular disease or family history of abdominal aortic aneurysm. Doppler ultrasonography of iliac and femoral arteries has been used for evaluation of peripheral arterial disease in patients with such aneurysm in other studies.²¹ We ignored it because of the extra cost of lower limb Doppler study. Another possible limitation of our study was the patients' recruitment. Although our hospital is a referral hospital, the results may not be representative of all the Iranian population. Another multicentric study on abdominal aortic aneurysm is underway with the leadership of our center.

In conclusion, the prevalence of abdominal aortic aneurysm is lower in Iranian candidates for CABG. Only the subgroup of older men (>65) with at least unilateral carotid stenosis more than 50% have high prevalence of this disease (10%).

In our study, age \geq 65, gender, smoking, smoking more than 40 years, diabetes, hypertension, and significant carotid stenosis were associated risk factors for abdominal aortic aneurysm. We do not recommend abdominal aorta screening for CABG candidates because of the low prevalence of abdominal aortic aneurysm in our population.

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