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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA

Radiological screening of abdominal aortic aneurysm in individuals over 65

65 yaş ve üzeri kişilerde radyolojik olarak abdominal aorta anevrizması taraması

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ABSTRACT

Objective: The aims of this study were to determine the prevalence of AAA in aged 65 years and above that had been referred for US screening, the association between risk factors for atherosclerosis and AAA, and the effectiveness of screening a population aged 65 years and above with atherosclerosis risk factors using ultrasound (US).

Methods: Patients 65 years and over who had undergone US examination for any reason were invited to participate. The 600 patients (335 male, 265 female) who agreed to participate completed a survey of atherosclerosis risk factors. Aneurysm levels in patients with infrarenal or suprarenal AAA were measured using US. Statistical analysis was performed to identify the relationship between AAA and several atherosclerosis risk factors.

Results: Of the 600 patients, 35 (5.8%; 33 male and 2 female) patients were diagnosed with AAA. Males and females represented 94.3% and 5.7% of the AAA-diagnosed population, respectively, and 5.5% and 0.3% of the screened population, respectively. Thirty of the AAA-diagnosed patients (85.7%) were between 65 and 79 years and 5 (14.3%) 80 years and above. A significant relationship was found between AAA and advanced age, male sex, smoking, and coronary artery disease and an inverse relationship between AAA and diabetes mellitus ($p<0.05$).

Conclusion: Individuals age 65 and over with atherosclerotic risk factors for AAA should be screened to prevent possible rupture. Performance of US in radiology clinics is an effective means of identifying these patients.

Key words: Abdominal aortic aneurysm, Doppler ultrasonography, public screening, ultrasonography

ÖZET

Amaç: Çalışmamızın amacı, radyoloji ünitesine başvuran 65 yaş ve üstü popülasyonda abdominal aort anevrizması (AAA) prevalansını ve ateroskleroz risk faktörleri ile AAA arasındaki ilişkiyi saptamaktır. Ayrıca 65 yaş ve üstü ateroskleroz risk faktörlerine sahip kişilerin US ile tarama etkinliğinin değerlendirilmesi amaçlanmıştır.

Yöntemler: Herhangi bir nedenle hastaneye başvuran 65 yaş ve üstü 335 erkek, 265 kadın toplam 600 olgu alındı. AAA risk faktörlerinin sorgulandığı anket doldurduldu. US ile anevrizması saptanan olgularda anevrizma seviyesi, uzunluğu varsa tromboze segment belirtildi. AAA'nın prevelansı ve ateroskleroz risk faktörleri ile ilişkisini araştırdık.

Bulgular: Toplamda 600 kişiden 35'i(%5,8) AAA tanısı aldı. AAA saptananların 33'ü erkek(%94,3), 2'si kadın(%5,7) olguydu. Erkeklerin %5,5'inde, kadınların %0,3'ünde AAA saptandı. AAA saptanan 35 olgunun 30'u (%85,7) 65-79 yaş aralığında, 5 olgu (%14,3) ise 80 yaş ve üzeriydi. Artan yaş, erkek cinsiyet, sigara kullanımı, koroner arter hastalığı ile AAA arasında istatistiksel olarak anlamlı ilişki, AAA ile diabetes mellitus arasında negatif ilişki saptandı ($p<0,05$).

Sonuç: AAA prevelansının 65 yaş ve üzeri ateroskleroz risk faktörleri bulunan popülasyonda yüksek olması nedeniyle bu grubun taranması, AAA saptananların tedavi edilmesi, rüptür riskinden korunmada önemlidir. Yüksek riskli kişilerin radyoloji kliniklerinde US ile AAA açısından taranması etkili ve güvenilir bir yöntemdir.

Anahtar kelimeler: Abdominal aort anevrizması, Doppler ultrasonografi, toplum taramaları, ultrasonografi.

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INTRODUCTION

Abdominal aortic aneurysm (AAA) is a localized dilation of the abdominal aorta (AA) exceeding the normal diameter by more than 3 cm in the infrarenal segment or an increase of more than 50% compared to the proximal segment [1-3]. Although the etiology of AAA is not clear, atherosclerosis is known to be a common cause [4]. Thus, identification of patients at the subclinical stage of atherosclerosis is important for the prevention of complications. Modifiable risk factors for atherosclerosis are hypertension, hyperlipidemia, diabetes mellitus (DM), obesity, and smoking, while nonmodifiable risk factors are genetic background, age, and sex [1,2]. The prevalence of AAA is increasing due to prolongation of lifespan and widespread atherosclerosis. Rupture of AAA is the 13th most common cause of mortality in the United States, respectively, in males over 65 years. [5]. The mortality rate of all cases of AAA rupture is approximately 80% [1,7]. Although the mortality rate decreases to 5% for patients with large aneurysms who undergo elective surgery, many patients who experience rupture die before reaching the hospital [1,6,8,9]. This increased rate reflects the fact that patients who undergo emergency surgery are generally older and have co-morbid diseases [10,11].

The most effective way of preventing death due to aneurysm rupture is early detection and elective AAA repair before rupture [12,13]. Most aneurysms are asymptomatic, two thirds of AAA cases are detected incidentally during radiological examination performed to investigate another condition [3,9]. Therefore, there is a great need to develop methods of AAA detection with high diagnostic value that are inexpensive and provide findings easily applicable for reducing morbidity and mortality due to rupture.

Ultrasound (US) is ideal scanning tools for detecting aneurysm because they show the vascular wall as well as the lumen, identify the thrombotic segment with high accuracy, are easy to access, can be performed at the bedside, are acceptable to patients, and do not require the use of contrast agents or subject patients to ionizing radiation [6,14]. US has been found to have high sensitivity (94–100%) and specificity (98–100%) in the diagnosis of AAA [15]. Although a recent multicenter study found that the screening of selected individuals above 65 years with risk factors reduced the incidence of rupture [14,16-18], Turkey has yet to establish a screening program.

The primary objective of this study was to determine the association between risk factors for atherosclerosis and AAA and to evaluate the importance and effectiveness of screening a population aged 65 years and above with atherosclerosis risk factors using US.

METHODS

Patients 65 years old and over who had undergone US examination at radiology department for any reason were invited to participate in the study. The inclusion criteria were age over 65 and willingness to participate in the study. Those who volunteered were informed about the procedures. All the procedures were performed according to the World Medical Association Declaration of Helsinki (revised in 2000, Edinburgh) and also under the permission of local ethical committee. Of the 727 patients invited to participate, 600 agreed to serve as subjects. The study procedures were explained to all the subjects, who all then provided their informed consent for participation. The subjects were then instructed to complete the survey of atherosclerosis risk factors (Table 1). On the questionnaire, reporting of use of oral antidiabetics or insulin and a fasting blood glucose level (FBG) >110 mg/dL was considered evidence of diabetes. Reporting of high cholesterol level (total cholesterol >200 mg/dl and low-density lipoprotein cholesterol >130 mg/dl) or use of lipid-lowering medication was considered evidence of hyperlipidemia. Reporting of use of antihypertensive drugs and systemic blood pressure >140/90 mmHg was considered evidence of hypertension. Reporting of history of cardiac infarction, history of bypass, and/or a stent placement was considered evidence of coronary artery disease (CAD). Reporting of temporary or permanent neurological deficits was considered evidence of cerebrovascular accident (CVA).

The AA was examined in the supine position under the diaphragm until aortic bifurcation and the iliac arteries examined likewise until iliac bifurca-

tion A diameter of more than 3 cm at the AA infrarenal level or a more than 50% increase in diameter compared to the proximal segment was considered evidence of AAA. Aneurysm levels in patients found to have infrarenal or suprarenal AAA were measured using gray-scale US and Color Doppler US (CDUS) to measure the largest transaxial diameter and the longitudinal elongation. The maximum diameter of the AA was measured to the outside of the vessel walls. The presence of thrombus was evaluated and the diameter of the open (non-thrombosed) lumen was measured. Patients with partial thrombosis were examined by CDUS to identify the open lumen. Patients with indications for endovascular and/or surgical treatment were recommended for assessment with computed tomographic angiography or magnetic resonance angiography.

Statistical analysis

Statistical analysis of the measurements was performed using the SPSS 18.0 software package (SPSS, Inc., Chicago, IL, USA). The descriptive statistics of the variables were described in terms of the mean, range, and standard deviation. Because the majority of the variables were categorical, the Pearson's chi-square and Fisher's exact chi-square test were performed for their analysis. In all tests, the level of significance was set at $p<0.05$ and the 95% confidence interval determined. Based on the results, logistic regression models were developed using the stepwise method (forward conditional) method to identify the association between AAA and risk factors for atherosclerosis.

RESULTS

Of the 600 patients who participated in this study, 335 were males (mean age 71.52 years) and 265 were females (mean age 71.88 years) of a mean age of 71.69 years (range 65–100 years). Among them, 528 (88%) were 65 to 79 years and 72 (12%) were 80 years and over. Infrarenal AAA (mean aneurysm diameter 42 mm, range 30–80 mm) was detected in 35 (5.8%) of the 600 patients. Among the 35 patients, the AAA diameter ranged from 3 to 3.9 cm in 18 (51.5%), from 4 to 5.4 cm in 12 (34.3%), and 5.5 to 8 cm in 5 (14.2%). The 33 males diagnosed with AAA represented 94.3% (33 of 35) of the AAA-diagnosed population and 5.5% (33 of 600) of the screened population. The two females diagnosed with AAA represented 5.7% (2 of 35) of the AAA-diagnosed population and 0.3% (2 of 600) of the screened population. Regarding age, 30 of the AAA-diagnosed patients (85.7%) were between 65 and 79 years and 5 (14.3%) 80 years and above.

Table 1 shows the results for the analysis of the risk factors for AA and their distribution by sex. As can be observed, the prevalence of AAA was found to be significantly higher in males than females ($p = 0.017$) and in patients 80 years and over compared to patients 65 to 79 years ($p = 0.045$). These findings indicate that the incidence of AAA increases with increasing age in terms of both the median and average age, reflecting the growth in aneurysm diameter with increasing age. Regarding lifestyle risk factors, 28 of the 234 patients who were current smokers were found to have AAA. Statistical analysis of these data revealed that AAA prevalence is significantly higher in smokers ($p = 0.003$). Regarding comorbid conditions, 23 of the 216 patients with CAD were found to have AAA. Statistical analysis of these data revealed a statistically significant association between the prevalence of AAA and CAD ($p = 0.004$).

Table 1. Number and incidence of risk factors by gender

Risk Factor	Male		Female		Total
	n	%	n	%	
Diabetes Mellitus	92	27.5	76	28.7	168
Hypertension	178	53.1	190	71.7	368
Hyperlipidemia	147	43.9	150	56.8	298
Coronary Artery Disease	141	42.2	75	28.3	216
Smoking	201	60	32	38.8	233
Alcohol Use	72	21.5	6	2.3	78
Acute or Chronic Renal Failure	31	9.3	18	6.5	49
Sedentary Lifestyle	121	36.1	113	42.6	234
Metabolic Disorder	10	3	17	6.4	27
Hematologic Disorder	5	1.5	12	4.5	17
Previous Surgery	211	63	162	61.1	373

Logistic regression analysis of the risk factors revealed a 1.07-fold greater risk of AAA with age 80 years and above compared to age 65 to 79 years, a 6.4-fold greater risk in males compared to females, a 4.2-fold greater risk in smokers compared to non-smokers, and a 3-fold greater risk in patients with

CAD compared to those without CAD. All these differences in risk were found to be statistically significant. An inverse relationship was found between AAA and DM. R2 values of the regression model was found 24% (Table 2). No significant relationship was found between AAA and the risk factors of atherosclerosis, HT, HL, alcohol use, sedentary lifestyle, obesity, kidney disease, metabolic disease, hematological diseases, or history of surgery.

Table 2. Results of logistic regression analysis of risk factors for abdominal aortic aneurisma

	B	S.E.	P value	OR
Age	0.068	0.034	0.045	1.070
Sex	1.854	0.774	0.017	6.388
Diabetes mellitus	-1.158	0.518	0.025	0.314
Smoking	1.443	0.478	0.003	4.235
Coronary artery disease	1.130	0.388	0.004	3.095

DISCUSSION

The prevalence of AAA in the general community is 3% to 8% [10]. In the Aneurysm Detection and Management (ADAM) study, Lederle et al. [8] instructed more than 120,000 volunteers aged 50 to 79 to complete a survey of AAA risk factors before evaluating them by US. Whereas they found the incidence of AAA 3.6%, we found an incidence of 5.8% in the present study. The reason for this difference may be because of the population examined in the current study was 65 years and over, and thus included patients 80 years of over, who have a higher incidence of AAA. In contrast, the population examined in the ADAM study was under 80 years and included patients aged 50 to 64 years, in whom aneurysm is rare.

Several studies have reported that AAA is 3 to 6 times more common in men than women [6,8]. In several studies, the prevalence of AAA in those aged over 65 years was found 4% to 14% in men and 0.35% to 6.2% in women [6,8,19,20]. In our study, AAA was detected in 5.5% of the male population, 0.3% of the female population, and 9.8% of the entire population that participated in the screening. Thus, AAA in was detected in 6 times more men than women, a finding that accords with the literature.

We found no significant correlation between the incidence of AAA and female sex. While the aneurysm expansion rate in women increases with age, as it does in men, rupture of small aneurysms has been observed to be more common in women than men. For this reason Scott et al. recommend screening women for AAA [20]. However, no studies have examined the benefits of screening women [8,9,16,21,22].

Our finding of a significant relationship between smoking and AAA supports the findings in the literature. Specifically, our finding of a 4-fold higher incidence of AAA in smokers accords with the 4.45- to 5.07-fold higher incidence of AAA in smokers reported by several studies [6,8,10,14,21]. According to many studies, smoking is the most important modifiable risk factor affecting the formation, expansion, and rupture of aneurysms [8,9,15]. Although the mechanism by which smoking promotes AAA development is unclear [24].

In the Rotterdam study, no significant association was found between HL and AAA in individuals screened for AAA in whom total cholesterol levels were measured [8,15]. While one study found a significant relationship between AAA and low high-density lipoprotein (HDL) levels [25], the findings regarding this association in the literature are mixed. While we found no significant relationship between AAA and HL, we did not evaluate our patients' HDL levels. Likewise, we found no significant association between HT and AAA. However, as the prevalence of AAA rupture is higher in patients with HT than the general population [6], HT should be considered an important risk factor for rupture.

Surprisingly, the majority of studies, including our study, have found an inverse relation between DM and AAA [8,14]. When this unexpected finding was obtained in the analysis of the first cohort of the ADAM study, it was criticized as possibly having been due to analysis of a relatively small population. Therefore, this relationship will be examined again in a larger population. If a subsequent study supports this finding, the existence of an inverse relationship between DM and AAA can be put supported more strongly. In support of the first cohort findings, one study conducted after their submission highlighted a reduced incidence of AAA in males

with DM [26]. Likewise, a meta-analysis of 13 studies published between January 1999 and April 2014 reported a negative relationship between the prevalence of AAA and DM [27]. As in our study, the ADAM study identified DM through administration of questionnaires asking about known DM, but did not conduct laboratory tests. Therefore, in both studies DM may not have been detected in patients with unknown DM.

Male sex, advanced age, smoking, CAD, and family history of AAA are associated with increased prevalence of AAA, while DM have been found to be protective factors against aneurysm [6,8,15,21]. Studies have revealed that screening programs could be improved to be more diagnostically and cost effective by only scanning for AAA in people with CAD, peripheral artery disease, and/or a family history, as well as smokers [5].

In the course of conducting this study we faced several limitations that should be considered when reviewing the findings. The first limitation of our study was that it examined a sample smaller than the large samples examined in population studies and consisted only of patients admitted to our hospital. A second limitation was that the presence of atherosclerotic risk factors was assessed by asking the patients whether they had these factors, based on the knowledge that previously diagnosed and treated patients are considered at risk. A third limitation was difficult to assess the diameter and extension of the aorta aneurysm in obese patients or patients with intense abdominal gas. Such difficulty is acknowledged as a general limitation of the scanning modes (US and CDUS) we used to examine our patients. Despite these limitations, our study is important because our findings were obtained by examination of a heterogeneous population that had been admitted to the hospital and included women. Also our findings support previous findings reported in the literature regarding the prevalence of AAA and the relationship between atherosclerosis risk factors and AAA. To our knowledge our study was the first to determine the incidence of AAA using US and compare the relationship between AAA and concomitant risk factors for atherosclerosis in Turkey.

Due to the lack of community screening of large populations in Turkey, the prevalence and incidence of AAA is unknown in the general Turkish population. Previous studies have found that US screening reduces the rate of mortality due to rupture by 21% to 68% [9,14-16,18]. In the UK, scanning members of the community at high risk of AAA but with no symptoms has allowed for the identification of asymptomatic AAA, leading to significant savings in health spending due to prevention of aneurysm rupture and other complications [6,10,28,29]. Based on this finding, an AAA screening program was initiated and funded by the Medical Research Council in the UK.

In conclusion, we found the prevalence of AAA over 65 years that had undergone US to be 5.8% and to be 6-fold higher in men than women (0.3% in females and 9.8% in males). We found that AAA is significantly associated with male sex, advanced age, CAD, and tobacco use but not with sedentary lifestyle, obesity, history of cerebrovascular disease, history of surgery, HL, HT, or alcohol use, consistent with the literature. Our findings indicate that rapid, effective aneurysm screening can be performed in radiology clinics without harm or inconvenience to the patient.

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