ORIGINAL ARTICLE

SCREENING FOR ABDOMINAL AORTIC ANEURYSMS

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OBJECTIVE AND METHODS: Screening for abdominal aortic aneurysms may be useful to decrease mortality related to rupture. We conducted a study to assess the prevalence of abdominal aortic aneurysms in southern Brazil and to define risk factors associated with high prevalence of this disorder. The screening was conducted using abdominal ultrasound. Three groups were studied: Group 1 – cardiology clinic patients; Group 2 – individuals with severe ischemic disease and previous coronary surgery, or important lesions on cardiac catheterism; Group 3 – individuals without cardiac disease selected from the general population. All individuals were male and older than 54 years of age. The ultrasonographic diagnosis of aneurysm was based on an anteroposterior abdominal aorta diameter of 3 cm, or on an abdominal aorta diameter 0.5 cm greater than that of the supra-renal aorta.

RESULTS: A total of 2.281 people were screened for abdominal aortic aneurysms in all groups: Group 1 - 768 individuals, Group 2 - 501 individuals, and Group 3 - 1012 individuals. The prevalence of aneurysms was 4.3%, 6.8% and 1.7%, respectively. Age and cigarette smoking were significantly associated with increased prevalence of aneurysms, as was the diagnosis of peripheral artery disease.

DISCUSSION: We concluded that screening may be an important tool to prevent the mortality associated with abdominal aortic aneurysms surgery. Additionally, the cost of screening can be decreased if only individuals presenting significant risk factors, such as coronary and peripheral artery disease, smokers and relatives of aneurysm patients, are examined.

DESCRIPTORS: **Aneurysm. Abdominal. Aorta. Screening. Infra-renal.**

INTRODUCTION

The prevalence of infra-renal abdominal aortic aneurysm (AAA) has been increasing in the last years, possibly due to the increase in life expectancy, increasing clinical suspicion and improved accuracy of imaging methods. This increase in prevalence is associated with an important mortality rate due to aneurysm rupture. Mortality due to rupture of AAA ranks 13th in the United States and 10th in Canada among men older than 65 years[1]. In addition, several authors have suggested an increase in the mortality rate due to rupture of AAA in the past decades in both the United Stated and England, with more than 14.000 and 7.259 deaths/year, respectively, in those countries[2,3]. Despite being significant, such figures are probably underestimated, since many deaths resulting from ruptured aneurysms are not proved by autopsy, and are consequently not documented[4]. Some researchers have reported that the overall lethality associated with rupture of AAA is around 80%, including dead on arrival patients or those who die before the diagnosis is made[5].

Concerning the incidence of AAA, a population-based study[6] in Rochester (MN), USA, found that the incidence of AAA per 100.000 people had increased from 12.2 in 1951-1955 to 36.2 in 1976-1980. In addition, those authors describe an increase in the number of elective operations as compared to operations for complica-

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tions within the same time interval, from 68% to 81%. There was also a significant increase in the number of small aneurysms (<5-cm), from 16% in the 1950s to 41% in the 1970s. Such data suggest a trend of increase in AAA frequency and mortality. Furthermore, elective procedures and operation of smaller aneurysms have become more common, probably due to the greater confidence in the results of surgical treatment. Several series worldwide have reported surgical mortality rates lower than 4%[7, 8].

The greater safety of elective AAA surgery associated with the high mortality due to rupture have led to a great interest on the early diagnosis of AAA, which may prevent the risk of emergency operations for rupture. However, AAA screening is usually very expensive and no reliable information are available concerning this preventive measure. In Brazil, the prevalence and incidence of AAA are not well known. More importantly, there have been no studies focusing on the adequacy of diagnosis and treatment of AAA in Brazil.

Therefore, this study was designed to assess the prevalence of AAA in southern Brazil, more specifically in the state of Rio Grande do Sul. Additionally, the study aimed to define risk factors associated with high prevalence of the disease, in order to provide information concerning which subset of individuals from the population could benefit from screening.

MATERIAL AND METHODS

Three groups were selected to participate in the study: Group 1 – cardiology clinic patients; Group 2 – patients undergoing coronary revascularization or presenting significant lesions on coronary catheterization; Group 3 – individuals from the general population chosen by strata to represent the population of Rio Grande do Sul. All individuals were male and older than 54 years of age. Women and men younger than 54 years were not included, since they are considered to be low-risk groups for AAA. In groups 1 and 2, individuals were selected consecutively at the hospitals involved in the study (Santa Casa de Porto Alegre and Instituto de Cardiologia de Porto Alegre).

For the third group, the sample size was calculated based on the number of males older than 54 years of age in the state of Rio Grande do Sul (495.000 according to IBGE*) with expected frequencies of 1.85% at best and 1% at worst and 95% confidence interval, as previously observed.[9] Individuals from the general population were recruited from different cities where this examination could be performed, in an attempt to include the major ethnic groups of our state. The following cities were selected: Carlos Barbosa, Garibaldi, Cruzeiro do Sul, Teutônia, Santo Ângelo and Santa Rosa. In all these cities, the population is largely of Italian or German descent, but there is also a significant percentage of individuals of non-European descent. In addition, their size allowed individuals to be recruited via radio or through a direct invitation made by general practitioners. All the individuals included in the study received a written invitation to participate, along with detailed explanation of the disease.

The screening procedure consisted of a medical interview and examination to define risk factors and presence of other diseases. After the interview, all individuals were submitted to abdominal ultrasound with measurement of the aorta in the supra- and infra-renal sections. All interviews were performed by the same physician (IS), as were all sonograms (IS). After the screening process, patients received a routine report with the results of the examination and suggested follow-up. The screening was carried out from 1987 to 1993, when all examinations were performed.

The results of sonograms were considered positive if the infra-renal aorta measured more than 3 cm in diameter or if this diameter was more than 0.5 cm greater than that of the supra-renal aorta. The patients with aneurysms were further categorized as presenting small and large aneurysms (less or more than 4.5 cm, respectively). Patients with small aneurysms had another examination after six months. Patients with large aneurysms were referred to vascular surgery counseling with an indication for surgery.

Information was collected concerning the epidemiological features of each individual, and the associated risks or diseases were recorded. Smoking was assessed through interview by defining and quantifying past history and current status. Hypertension and ischemic heart disease were considered in patients with proven history or use of drugs. Group 2 patients had cardiac catheterization showing more than 70% of stenosis in the coronaries and indication for surgery. Peripheral arteriopathy was considered in patients with diminished pulses and typical claudication.

Prevalence ratio with 95% confidence interval was calculated for each of the associated factors or diseases using the Mantel-Haensel formula. The chi-square (Yates correction) was used to test associations between AAA and related factors (age, smoking, hypertension and arterial diseases). To identify factors independently associated with AAA, uni- and multivariate logistic regression were performed. An error probability of $p<0.05$ was considered to be significant.

*** IBGE – Brazilian Institute for Geography and Statistics.**

RESULTS

A total of 2.281 individuals were screened during a period of 28 months. The individuals selected for the study were all male and older than 54 years, totaling 768 (33.7%) in Group 1, 501 (22%) in Group 2 and 1.012 (44.4%) in Group 3. From this total of individuals, 84 AAA were diagnosed, representing 3.7% of the examinations (Table 1). The cost of each sonogram and interview was R$ 10.00 (US$ 4.00). The cost per diagnosed aneurysm in each group is shown in Table 1.

The association of risk factors and diseases was analyzed separately in each group. The frequency of AAA according to risk factors and diseases in Group 1 patients is presented in Table 2. The only risk factor that was strongly and significantly associated with AAA according to this analysis was cigarette smoking. Subsequent logistic regression analysis (Table 3) revealed that age was also significantly associated with the presence of AAA in these patients.

Group 2 had an overall AAA prevalence of 6.8%. Table 4 shows the frequencies of risk factors or associated diseases for patients in Group 2. This analysis revealed no differences between patients with and without aneurysm in this group. However, logistic regression revealed that age was significantly higher in patients with aneurysm than in those without aneurysm in this group (Table 5). The prevalence of aneurysms increased from 2% in 55 year-old patients to 8% and 17% in 70 and 80 year-old patients, respectively.

Group 3 (general population) had 17 aneurysms (1.7%), which were significantly associated with smoking and age. Among the smokers in Group 3, the overall prevalence of aneurysms was 2.67%, versus 1.18% in non-smokers. The presence of peripheral artery disease was associated with the pres-

Table 1 - Prevalence of AAA and cost per diagnosed aneurysm.

Group	Number of individuals	Number of AAA	%	Cost per aneurysm Brazilian reais (US$)*
Group 1 – cardiology clinic	768	33	4.3	233 (94)
Group 2 – coronary bypass	501	34	6.8	147 (59)
Group 3 – population	1012	17	1.7	595 (240)
Total	2281	84	3.7	238 (96)

*R$ 10.00 (cost of each sonogram) multiplied by the total number of individuals in each group and divided by the number of aneurysms in the group.

Table 2 - Absolute and relative frequency of aneurysms according to the presence or absence of risk factors or associated diseases in Group 1 patients (cardiology clinic).

Variable	Status	AAA	%	RR	CI	P
Myocardial Disease	Present	24/486	4.9	1.55	0.74-3.28	0.33
	Absent	9/282	3.2			
Hypertension	Present	17/457	3.7	0.72	0.37-1.41	0.43
	Absent	16/311	5.1			
Smoking	Present	29/467	6.2	4.67	1.66-13.2	0.02*
	Absent	4/301	1.3			
Diabetes Mellitus	Present	1/110	0.9	0.19	0.03-1.35	0.101
	Absent	32/658	4.9			
Peripheral artery disease	Present	4/101	4.0	0.91	0.03-2.54	
	Absent	29/667	4.3			

*Statistical significance.

Table 3 - Logistic regression analysis of risk factors in Group 1 patients (cardiology clinic).

	Univariate				Multivariate			
Variable	Coef.	OR	CI	P	Coef.	OR	CI	P
Hypertension	-0.341	0.71	0.35-1.43	0.33	-0.332	0.71	0.35-1.47	0.364
Myocardial disease	-0.453	1.57	0.72-3.43	0.26	0.505	1.66	0.745-3.691	0.215
Smoking	1.596	4.93	1.72-14.18	0.003*	1.859	6.42	2.18-18.89	0.0007
Age	0.061	1.063	1.01-1.12	0.018*	0.075	1.08	1.022-1.139	0.005
Diabetes Mellitus	-1.727	0.178	0.02-1.12	0.09	-1.875	0.153	0.002-1.15	0.06
Peripheral artery disease	-0.096	0.91	0.31-2.64	0.86	-1.170	0.843	0.281-2.528	0.76

* Statistically significant difference.

Table 4 - Absolute and relative frequency of aneurysms according to the presence or absence of risk factors in Group 2 patients (significant coronary obstruction).

Variable	Status	AAA	%	RR	CI	P
Hypertension	Present	21/257	8.17	1.53	0.79-2.99	0.27
	Absent	13/244	5.32			
Smoking	Present	24/368	6.52	0.96	0.47-1.95	0.93
	Absent	10/143	6.99			
Diabetes Mellitus	Present	7/84	8.33	1.29	0.58-2.86	0.7
	Absent	27/417	6.47			
Peripheral artery disease	Present	3/64	4.68	0.66	0.21-2.1	0.65
	Absent	31/437	7.09			

*Statistical significance.

ence of aneurysms, although after including smoking as the independent variable this association was weakened. Hypertension, myocardial disease and diabetes mellitus were not associated with prevalence of aneurysm (Table 6). The prevalence of AAA in Group 3 increased with age to a lesser extent than in Groups 1 and 2, as shown in Table 7.

From 2.281 examinations, 17 aneurysms had indication for surgery following the criterion of size of 4.5 cm or more. Ten were operated with good results, without mortality or complications. Seven patients refused operation.

DISCUSSION

The main purpose of this study was to assess the prevalence of abdominal aortic aneurysm in southern Brazil, so as to obtain information concerning which groups would profit from screening.

Table 5 - Logistic regression analysis of risk factors in Group 2 patients (significant coronary obstruction).

	Univariate				Multivariate			
Variable	Coef.	OR	CI	P	Coef.	OR	CI	P
Hypertension	0.458	1.58	0.773-3.232	0.209	0.647	1.911	0.9-4.019	0.087
Smoking	-0.04	0.95	0.44-2.05	0.90	0.088	1.092	0.49-2.416	0.827
Age	0.0875	1.09	1.034-1.152	0.002*	0.099	1.104	1.043-1.168	0.0006
Diabetes Mellitus	0.272	1.31	0.552-3.123	0.53	0.363	1.439	0.582-3.559	0.43
Peripheral artery disease	-0.4399	0.64	0.191-2.171	0.478	-0.67	0.512	0.145-1.8	0.29

* Statistically significant difference.

Table 6 - Absolute and relative frequency of aneurysms according to the presence or absence of risk factors or associated diseases in Group 3 individuals (general population).

Variable	Status	AAA	%	RR	CI	P
Myocardial Disease	Present	3/104	2.88	1.87	0.55-6.4	0.54
	Absent	14/908	1.54			
Hypertension	Present	9/337	2.67	2.25	0.88-5.79	0.14
	Absent	8/675	1.18			
Smoking	Present	16/675	2.37	7.99	1.06-59.9	0.05
	Absent	1/337	0.29			
Diabetes Mellitus	Present	1/73	1.36	0.8	0.11-5.9	0.79
	Absent	16/939	1.70			
Peripheral artery disease	Present	5/115	4.34	3.25	1.17-9.06	0.05
	Absent	12/897	1.33			

*Statistical significance using risk probabilities.

Table 7 - Correlation between prevalence of AAA and age in Group 3 individuals (general population).

Age	Number of patients	Number of AAA	%
55-64	312	2	0.64
65-74	558	11	1.97
75 or more	141	4	3.2
Total	1011	17	1.7

The cost-effectiveness of screening for AAA is extremely difficult to measure. One factor that should be taken into consideration is mortality: the mortality associated with elective operations is significantly lower than the mortality associated with both operated and non-operated ruptured aneurysms. Lindholt et al.[10] screened 12.658 individuals older than 65 years in Denmark, offering screening and surgery for nearly half of them. The study suggested that screening might be cost-effective in terms of years of life saved, since there was a great difference in terms of mortality.

The results obtained in the present study can be extrapolated to the general population. Darling et al.[11] found a rupture rate of 25% for aneurysms greater than 4 cm and of 9.5% for smaller aneurysms. Considering these rupture rates, the patients participating in our study would have 11 ruptures in the next 5 years. There are approximately 495.000 males older than 54 years in the state of Rio Grande do Sul. Among those, 8.415 probably have aneurysms, which represents over 1 000 ruptures. Thus, the total cost of screening for all males older than 54 years in our state would be R$ 4.950.000 (US$ 2.000.000); this means about 1.000 diagnosis before rupture, totaling R$ 4.950 (US$ 2.000) for each rupture prevented. Although these conjectures are not derived from actual data, the extrapolation provides interesting insights.

Certain groups may benefit more from AAA screening than others, mainly considering cost issues. Women are less affected by the disease, as suggested by several studies[9,12]. Although the prevalence of AAA in women is unknown in our region, we excluded this group from the study based on a pilot study, in which 333 women were examined and only 2 small aneurysms were found. The authors' personal experience also shows

a low prevalence of rupture among women – 3 out of 60 consecutive ruptures operated in our hospital[8]. Thus, it seems that screening for AAA in women is not cost-effective, due to the low prevalence of the diagnosis and of aneurysm-related complications.

On the other hand, the prevalence of AAA is high in certain groups. These groups can be identified by the presence of associated diseases and risk factors for AAA. For example, we observed that the prevalence of aneurysm in smokers is more than sevenfold that of non-smokers of the same age. Furthermore, the association between peripheral artery disease and aneurysm was three times stronger than the association between absence of the disease and aneurysm in Group 3 (general population). Obviously, the statistical significance of peripheral artery disease disappeared after regression for smoking, since smoking is a risk factor for both aneurysm and atherosclerosis. We did not observe an association between peripheral artery disease and aneurysm in Groups 1 and 2. However, the importance of peripheral artery disease as an indicator of risk for aneurysm should not be downplayed. This disease is a marker of further arterial disease and its presence should encourage physicians to indicate screening. In the same way, the presence of coronary artery disease increased four-fold the risk for aortic aneurysms in our study in Groups 2 and 3.

Another important factor is age. AAA is uncommon before 50 years of age and increases in frequency yearly after 54 years of age. Our study showed an increase in incidence of almost 0.1% per year in Group 2, and a slightly smaller increase in the other two groups**.** Thus, advanced age may be considered as an associated condition, responsible for an important increase in the incidence of AAA. Concerning elderly individuals, the prevalence observed by Bengtsson et al. [13] in 375 males of 74 years of age (10.7%) corroborates our observation of increased prevalence with advancing age.

The factors discussed in this paper, namely (1) cigarette smoking, (2) coronary and peripheral artery disease and (3) age are associated with a high incidence of aneurysms and should be used to guide screening programs and decrease the costs associated with such programs. The first two factors are not difficult to evaluate, and may be used as criteria to refer patients for screening. Age is extremely debatable as an indication for screening, since there is no consensus over the best age for screening.

One limitation of our study must be emphasized – although our sample was large, it was not representative of the general population due to the great difficulty in performing sonograms in group 3 (general population). However, we do not believe that this compromises the validity of our overall results.

In conclusion, although the cost-effectiveness of screening is still a matter of debate, our results suggest that screening for AAA may be extremely important in high-prevalence groups, such as patients with coronary or peripheral artery disease, long term smokers and older males. Our study also showed association of peripheral artery disease with AAA in males over 54 years of age without cardiac disease, suggesting screening to be recommended in this age group. Patients with cardiac diseases (groups 1 and 2) had high prevalence of aneurysm, suggesting that this group may be effectivelly screened due to its high risk of disease.

See Editorial in this issue.

RESUMO

BONAMIGO TP e col. - Rastreamento de aneurismas da aorta abdominal. **Rev. Hosp. Clín. Fac. Med. S. Paulo 58**(2):63-68, 2003.

OBJETIVO E MÉTODOS: O rastreamento de aneurisma da aorta abdominal infra-renal é importante pois pode diminuir a mortalidade relacionada à ruptura. Realizamos um estudo para definir a prevalência desses aneurismas em diversos segmentos da população em nossa região do Brasil. O rastreamento foi realizado utilizando-se a ecografia de abdômen. Três grupos foram estudados: Grupo 1 – pacientes de ambulatório de cardiologia; Grupo 2 – indivíduos com cardiopatia isquêmica grave detectada através de cateterismo; Grupo 3 – indivíduos sem doença cardíaca da população em geral. Todos os indivíduos examinados eram do sexo masculino e tinham idade superior a 54 anos. O diagnóstico ultra-sonográfico foi feito utilizando como critério o diâmetro ântero-posterior infra-renal superior a 3 cm ou 0,5 cm maior do que o da aorta supra-renal.

RESULTADOS: No total, 2 281 indivíduos foram submetidos ao rastreamento. O Grupo 1 incluiu 768 indivíduos; o Grupo 2, 501; e o Grupo 3,

1.012 indivíduos. A prevalência de aneurisma foi 4,3%, 6,8% e 1,7%, respectivamente. Idade avançada e tabagismo foram significativamente associados com aumento na prevalência de aneurismas, assim como a presença de arteriopatia periférica das coronárias.

DISCUSSÃO: Concluiu-se que o rastreamento de aneurismas da aorta abdominal pode ser utilizado para diminuir a alta mortalidade decorrente de ruptura através de tratamento adequado. O custo do rastreamento pode ser diminuído se utilizarmos apenas grupos com características associadas a alta prevalência de aneurismas, entre os quais estão os fumantes, idosos, familiares de pacientes com a doença e pacientes com doença arterial coronária ou periférica.

DESCRITORES: **Aneurisma. Abdominal. Aorta. Rastreamento. Infrarenal.**

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