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Originals

The Spontaneous Course of Small Abdominal Aortic Aneurysms. Aneurysmal Growth Rates and Life Expectancy

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Summary. Since abdominal ultrasonography has become a routine diagnostic procedure, increasing numbers of small asymptomatic abdominal aortic aneurysms are detected incidentally. Of 128 patients (108 male, 20 female) with abdominal aortic aneurysms, 96 patients were observed clinically and by repeated ultrasound studies for an average of 3.47 years, adding up to a total observation period of 333 patient-years. Among these 96 patients, 72 had small aneurysms (averaged diameters less than 5 cm). Three of them were lost to follow up. None of the remaining 69 patients died from rupture, 20 died from other causes and 8 patients were successfully operated. Of the patients with a large aneurysm one was lost to follow up. Five patients of the remaining 23 died as a result of rupture, 7 were successfully operated. The average growth rate of small aneurysms was 0.18 cm/year, whereas the larger aneurysms showed a growth rate of 0.28 cm/year (diameter).

The survival rate of patients with small aneurysms was 94% after one year, 80% after 3 years, and 73% after 5 years, indicating that life expectancy is reduced in patients with an aneurysm of the abdominal aorta, but not because of complications of the aneurysm.

Key words: Sonography – Ruptured aneurysms – Abdominal aortic aneurysm

Patients and Methods

All 128 patients in whom an abdominal aortic aneurysm has been discovered during routine abdominal sonography were included in this study.

At entry the patients' ages ranged from 39 to 90 years, the average age was 69.8 years. The men's average age was 68.7 years, while the women had an average age of 75.5 years (Fig. 1). The average observation time was 3.47 years, adding up to a total observation period of 333 patient-years. 32 patients were seen only once; their data are included in the evaluation of risk factors and life expectancy but not used for the calculation of the growth rate. Preliminary results have been described before [31, 70].

An abdominal aneurysm is defined as a localized widening of the aorta in which the average diameter is more than 2.5 cm (Fig. 2) [40].

All aneurysms were fusiform and probably arteriosclerotic in origin. Seven patients with an ectasia of the whole abdominal aorta were not included.

To calculate the average growth rate of an abdominal aortic aneurysm the difference between the most recent and the earliest measurement of the diameter is divided by the number of years of observation.

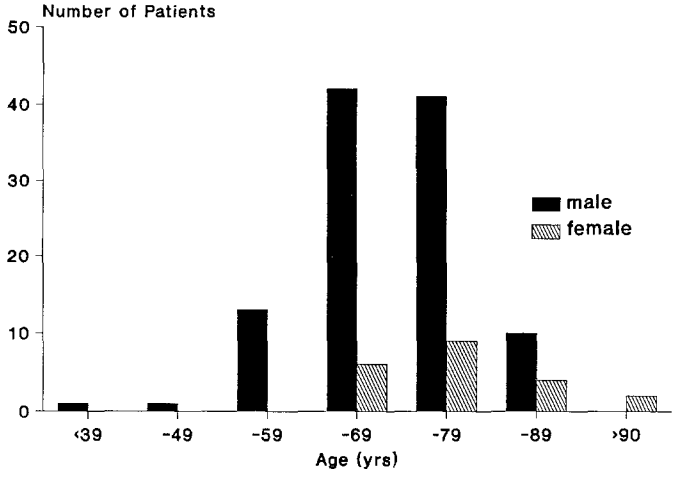

Fig. 1. Distribution of age and sex in 128 patients with abdominal aortic aneurysms

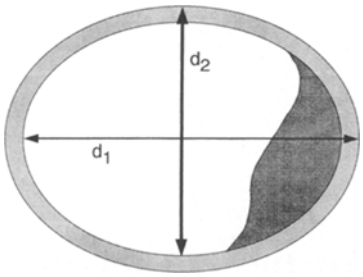

Fig. 2. Measurement of the sagittal and transverse diameter of an aortic aneurysm. The average diameter (cm) is calculated according to the following formula: $d = 0.5\ (d_1 + d_2)$

Table 1. Risk factors of abdominal aortic aneurysms in 128 patients

Overall distribution of risk factors for the development of abdominal aortic aneurysms		Number of patients presenting with a single or no risk factgor	
Risk factor	Number of patients (%)	Risk factor	Number of patients (%)
Hypertension	66 (52%)	Hypertension	18 (14%)
Smoking	59 (46%)	Smoking	19 (15%)
Hyperlipidemia	30 (23%)	Hyperlipidemia	7 (5%)
Diabetes	15 (11%)	Diabetes	3 (2%)
		None	18 (14%)

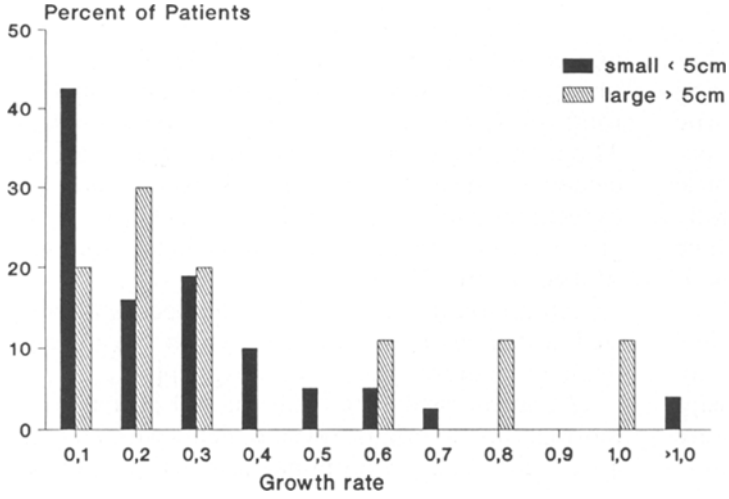

Fig. 3. Growth rate (cm/year) of abdominal aortic aneurysms in 96 patients

The survival rate of the patients suffering from abdominal aortic aneurysms who were not treated surgically was determined using the life table analysis of Cutler and Ederer [43].

Results

Abdominal aortic aneurysms are five times more common in men then in women. 51% of the patients were older than 70 years and 12% were older than 80 years. At the time of writing, after an average of 3,47 years following diagnosis, 90 (70%) of the 128 patients are still alive; 33 (26%) patients died during the observation period.

16 (48%) died from myocardial infarction or cardiac failure secondary to cardiovascular disease and four from stroke. In five cases death was caused by malignancy and in three by pneumonia. Five patients died from aneurysmatic bleeding; their aneurysms were greater than 6.0 cm in averaged diameter (6.0 cm; 6.5 cm; 6.7 cm; 8.5 cm; 9.0 cm), and all patients were suffering from severe abdominal or back pain. The cause of death in five patients was unknown (4.5 cm; 4.7 cm; 4.8 cm; 5.0 cm; 6.35 cm). To our knowledge thus far none of the patients with an asymptomatic aneurysm smaller than 5.0 cm has died from a complication of the aneurysm.

Most patients presented with risk factors for coronary heart disease (Table 1). The strong association between cigarette smoking and aortic aneurysm has been documented in several epidemiologic studies [2, 30, 35]. Hypertension is common in patients with abdominal aortic aneurysms and it is possibly a pathogenetic factor. Moreover, hypertension may produce a predisposition to rupture, shorten survival after resection and contribute to the development of false aneurysms [53, 59]. Diabetes and hyperlipidemia seem to be of little importance in regard to aneurysm formation (Table 1).

Most of the small asymptomatic abdominal aortic aneurysms grow slowly. While 72 small aneurysms showed a mean growth rate of 0,18 cm/year, 24 aneurysms with a diameter of over 5 cm had a growth rate of 0.28 cm/year (Fig. 3). In a few cases, small aneurysms grew rapidly, 15 of

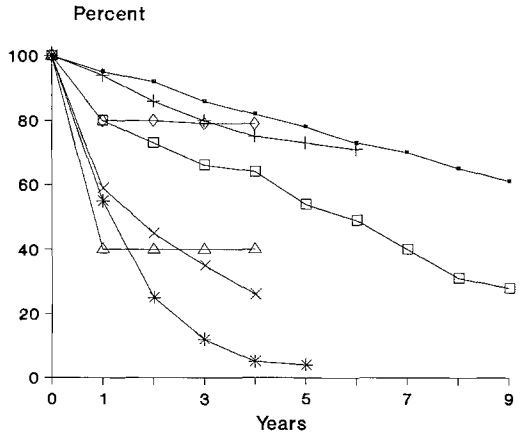

Fig. 4. Survival rate of 98 patients with small abdominal aortic aneurysms of the Medizinische Poliklinik of the University of Munich compared to survival other study populations [6, 54, 62]

them exhibited a growth rate greater than 0.28 cm. If these were excluded from the calculation of growth rates of small aneurysms, their growth rate would be 0.09 cm/year.

A one-year survival rate of 94%, a 3-year survival rate of 80%, and a 5-year survival rate of 73% was found (Fig. 4). Men with abdominal aortic aneurysms have a better prognosis than women. The survival graph of patients with small abdominal aortic aneurysms is compared to those of other authors in Figure 4.

Discussion

Ultrasonography and computed tomography are used as routine diagnostic measures; therefore abdominal aortic aneurysms are diagnosed more often than before. A true increase in the prevalence of abdominal aortic aneurysms cannot be ascertained [27]. Abdominal aortic aneurysm is a disease of the elderly and occurs most frequently between the seventh and ninth decade [4, 37, 70].

Advanced age is no contraindication for surgery because the operative mortality has progressively decreased (2 to 6 percent with elective surgery) [6, 19, 20, 45, 67, 69]. Postoperative mortality, however, exceeds operative mortality [5, 58, 67].

Most of the patients suffer from hypertension and serious cardiovascular diseases [4, 6, 11, 22, 33, 37, 40, 54, 59]. Brown et al. report on 422 patients, of whom 41% had a history of either myocardial infarction or angina pectoris and 35% had a previous myocardial infarction [11]. Female patients and those over 70 deteriorate in postoperative prognosis; in patients with coronary heart disease or myocardial, respiratory or renal insufficiency operative mortality is doubled or even higher [21, 45, 64].

Most reports state that patients with abdominal aortic aneurysms have a bad prognosis unless they undergo surgery [4, 14, 22, 23, 24, 26, 44, 48, 54, 61]. Our experiences do not support these claims.

What are the reasons for the considerable differences between our results and those of other authors? Many earlier series dealing with the natural course of abdominal aortic aneurysms [22, 25, 32] refer to studies which are 15–30 years old [24, 56, 62]. At that time diagnostic possibilities were limited, and most abdominal aortic aneurysms became evident by symptoms or rupture. Some recent series are based on negatively selected case material [25, 36, 52, 65]. Kessler and Gaylis reported about 205 of 221 patients as having aneurysms with a transverse diameter of more than 7 cm [36]. Fielding et al. described symptomatic large aneurysms, of which 91% could be palpated during physical examination [25].

Today, increasing numbers of small asymptomatic aneurysms are detected by ultrasonography, invalidating the prognostic prediction of earlier series. Compared to the large symptomatic aneurysms, small asymptomatic abdominal aortic aneurysms have a much better prognosis than assumed so far, particularly when the causes of death are analyzed [46].

It is noteworthy that some authors do not report how many of their patients died as a result of rupture. In fact, it seems that, almost as many died from other arteriosclerotic complications, such as myocardial infarction or stroke [18, 40, 55, 56, 61, 68].

The size of an aneurysm strongly influences the likelihood of rupture [45, 57]. The risk of rupture of an aneurysm with a diameter of 5 cm or less is 5 to 15% within five years, whereas it exceeds 75% during the same period of time in aneurysms with a diameter of 8 cm or more [3, 8, 10, 26, 37, 61, 62].

Small abdominal aortic aneurysms tend to grow slowly. The average growth rate lies between 0.1 and 0.4 cm/year, which is in agreement with our data [8, 13, 25, 46, 51, 68]. In our study population, a positive correlation between the aneurysmal diameter and the growth rate could be ob-

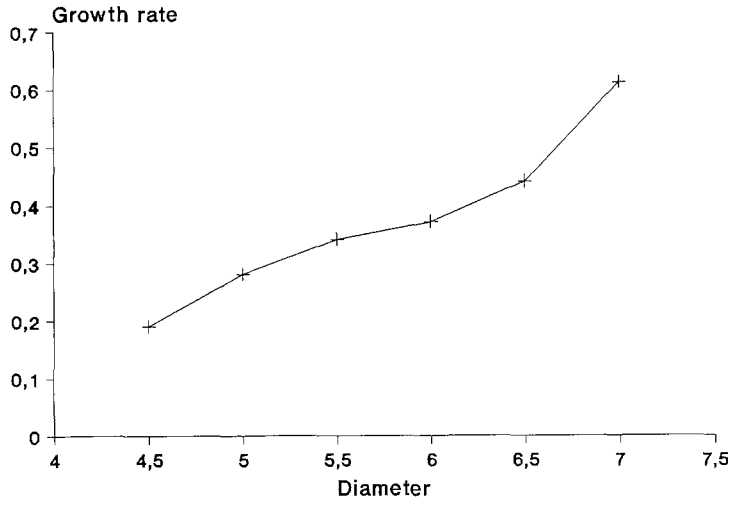

Fig. 5. Relation between aneurysm diameter (cm) and annual growth rate (cm/year)

served. The larger the initial diameter of the aneurysm, the greater is the average growth rate. Small aneurysms (< 5 cm) had an average annual growth rate of 0.18 cm; the growth rate of aneurysms with a diameter greater than 6 cm was 0.37 cm/year (Fig. 5), [7, 8, 13, 40, 60].

A small retrospective study showed that beta-blocking is associated with a significantly decreased growth rate of abdominal aortic aneurysms [41].

In our series not one of the 72 patients with a small asymptomatic abdominal aneurysms died as a consequence of rupture. Similar results are reported by other authors [7, 9, 46, 60]. The 5-year survival rate of our patients receiving nonresective treatment (73%) is even higher than the 5-year survival rate (65%) of a recently published series of 206 patients with a medium age of 63 years who underwent elective aneurysmectomy [47]. In particular, older patients with small asymptomatic aneurysms appear to die from other cardiovascular complications [56, 61]. The survival rate of our study population is strikingly similar to that reported by Nevitt et al. who during five years observed no rupture among 130 patients with aneurysms less than 5 cm in diameter [46].

However, as the individual growth rate cannot be predicted, patients with abdominal aortic aneurysms must be examined by ultrasonography every three to six months in order to detect those with a rapid growth rate.

Treatment of risk factors such as hypertension should be instituted. Patients with an aneurysmal diameter of 5 cm or larger and rapid enlargement, presence of pain or tenderness, peripheral embolism, obstruction of adjacent viscera, gastrointestinal bleeding, or signs of dissection or rupture are advised to undergo surgery.

Vascular surgeons propose elective resection for all aneurysms before symptoms or complications arise, referring to the decreased operative mortality during the last ten years [19, 20, 45, 67, 69]. On the other hand, most patients with aortic aneurysms are elderly and suffer simultaneously from other serious diseases [1, 4, 22, 29, 37, 42, 54, 63].

Obviously the limit of 5 cm as a means of distinction between cases with good or bad prognosis is still preliminary and may very well need adjustment.

Table 2 illustrates the influence of different cut-off levels for the definition of a "small" versus a "large" aneurysm on the probability of death from rupture in the resulting subgroups. The mortality of patients with an aneurysmal diameter greater than 6.0 cm was 50%. None of the patients with an aneurysmal diameter smaller than 6.0 cm has died from an aneurysm-related complication. If a diameter of more than 5 cm was an indication for surgery, 14 patients (15%) with a diameter between 5.0 cm and 6.0 cm would have undergone an unnecessary operation.

We agree with Cooley and Carmichael that today the cost/benefit ratio has to be considered more precisely [17]. The prevalence of abdominal aortic aneurysms is estimated to be 1 to 4% in a male population [12, 52, 65]. The Oxford screening program for abdominal aortic aneurysms in men aged 65 to 74 years found a prevalence of 5.4% in 426 unselected men [16]. In men aged 50 to 75 years suffering from hypertension, cardiovascular, cerebrovascular or peripheral vascular disease, an abdominal aortic aneurysm is diagnosed in 7 to 20% [1, 29, 42, 63]. We agree with those authors who propose routine ultrasound examinations in elderly men, especially if they suffer from

Table 2. Influence of arbitrary variation of the cut-off level on the accuracy in predicting death from aneurysmal rupture during the observation period

Cut-off Diameter	Number of patients	Number of deaths caused by rupture	Probability of death from aneurysmal rupture in different subgroups
<5 cm	72	0	0%
>5 cm	24	5	21%
<5.5 cm	80	0	0%
>5.5 cm	16	5	31%
<6 cm	86	0	0%
>6 cm	10	5	50%
<6.5 cm	88	1	1%
>6.5 cm	8	4	50%
<7 cm	91	3	3%
>7 cm	5	2	40%

severe arteriosclerosis [11, 15, 16, 29, 42, 49, 63, 64].

A most interesting fact is a familial tendency toward the formation of an aneurysm. After adjustment for age and sex, Johansen and Koepsell found an estimated 11.6-fold increase in the risk among persons with an affected first-degree relative [34]. Since thorough examination and observation of patients with an abdominal aortic aneurysm is necessary, ultrasound screening to detect early aneurysmal formation in relatives of patients with aortic aneurysms may be warranted. We have not studied this problem until now.

Ultrasound provides an excellent means for the detection of abdominal aneurysms. There is no need for alternative methods. Ultrasound is rapid, inexpensive, noninvasive, highly sensitive, and specific both to the presence and size of abdominal aortic aneurysms [29, 42]. Screening people by NMR [28] is economically not feasible.

Our data indicate, that the spontaneous course of small abdominal aortic aneurysms not treated by surgery is much better than assumed so far. Conservative treatment of risk factors, especially in the elderly, is justified if these patients are controlled by ultrasonography every three to six months.

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