

## Rupture of Abdominal Aortic Aneurysms in Patients Under Screening Age and Elective Repair Threshold

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### WHAT THIS PAPER ADDS

All patients treated for ruptured abdominal aortic aneurysm (RAAA) in two hospitals were analyzed to evaluate how many of them were not within the elective repair threshold or screening age. Surprisingly many RAAA patients were under 65, especially among smokers (28%). The mean AAA diameter at the time of rupture was significantly smaller among women: 5.6% of men had a rupture at under 55 mm and 11.5% of women at under 52 mm, which are the operative limits according to the European guidelines. It seems that current practice for AAA screening age and guidelines for size threshold may underestimate the risk of rupture.

**Objectives:** The objective of this study was to identify the proportion of abdominal aortic aneurysm ruptures that occur before the screening age or threshold diameter for operative repair is reached.

**Methods:** The study was a retrospective analysis of RAAA patients including all RAAA patients admitted to Helsinki (HUH) and Tampere University Hospitals (TaUH) during 2002–2013. The data for age, gender, and comorbidities were collected from vascular registry and patient records. Computed tomography images taken at the time of admission were used for the measurement of maximum anteroposterior (AP) aneurysm diameter at the time of rupture. Age and diameter data were compared with risk factors.

**Results:** A total of 585 patients diagnosed with RAAA were admitted to the two hospitals during the 12 year period. The mean age at the time of rupture was 73.6 years (SD 9.5, range 42–96 years). 18.3% of patients were under 65: 21.4% of men and 3.0% of women. Men were on average 8 years younger than women. The odds ratio (OR) for rupture before 65 years of age for smokers was 2.1 compared with non-smokers, and 28.4% of smokers were under 65 at the time of rupture. Of all RAAA patients, 327 had a computed tomography scan confirming rupture. The mean AP diameter of the aneurysm was 75.6 mm (SD 15.8, range 32–155 mm). The mean size was significantly lower in women than in men (70.5 vs. 76.8,  $p = .005$ ).

**Conclusions:** The data from this study show that a fifth of men would not make it to the screening age of 65 before AAA rupture, the proportion being even larger in active smokers. The data from this study also supports the previous finding that aneurysm size at the time of rupture is significantly smaller in women.

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### INTRODUCTION

Ruptured abdominal aortic aneurysm (RAAA) carries a very high mortality that has not been significantly reduced even as treatment methods have evolved.<sup>1–3</sup> Most aneurysms are asymptomatic until rupture. The key in reducing AAA related mortality is to identify patients

before rupture. To achieve this, AAA screening programs have been implemented in many countries.<sup>4–6</sup> Most AAA patients do not die of rupture but of other causes, and predicting AAA growth rate and rupture risk is problematic. This makes operative decisions difficult with asymptomatic aneurysms. The decision for operative treatment is mostly based on AAA diameter. According to the practice guidelines of the European Society for Vascular Surgery the AAA diameter beyond which operative treatment should be considered is 55 mm for men and 52 mm for women if the risks for elective repair are not significantly increased.<sup>7</sup> The American practice guidelines published by the Society for Vascular Surgery recommend repair for patients with AAA maximum diameter of 55 mm or larger without significant comorbidities, and suggest that young,

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healthy patients and especially women may benefit from repair even with a maximum diameter between 50 and 54 mm.<sup>8</sup> This lower threshold for women is not based on robust evidence, as aneurysm prevalence among women is markedly lower than among men. A proportion of AAAs rupture before screening age and operative threshold diameter, and currently there is no way of differentiating these patients.

AAA prevalence rises with age. Smoking is a clear risk factor for developing an AAA, another is a positive family history. Smoking is also known to increase the rate of aneurysm growth and the risk of rupture. Women have a higher rupture risk than men, although there is no difference in the rate of aneurysm growth.<sup>9–11</sup> Medical therapy beyond the control of general risk factors of atherosclerotic disease has not been shown to be effective: a recent Cochrane review of pharmacological treatment to reduce the mortality and cardiovascular events in AAA patients found insufficient evidence to draw any conclusions.<sup>12</sup>

The aim of this study was to identify the proportion of RAAAs that occur before screening age or threshold diameter for operative repair is reached and whether there are differences in risk factor profiles between early and late ruptures.

## MATERIALS AND METHODS

### RAAA and patient age

Helsinki and Uusimaa district in southern Finland has a population of 1.6 million. All elective and emergency AAAs are treated in the vascular surgical unit of Helsinki University Hospital (HUH). Similarly, RAAA patients in the Pirkanmaa district (population 520,000) are treated in Tampere University Hospital (TaUH). Hospital records were searched for all RAAA patients who were admitted to HUH and TaUH during 2002–2013. Data for risk factors were collected from the vascular registry and patient records. Data for patient age and gender, smoking status, history of coronary artery disease, hypertension, dyslipidemia, diabetes, pulmonary disease and stroke/transient ischemic attack (TIA) were collected.

In the first analysis, how well the currently used screening protocols would have found the patients who sustained RAAA was evaluated in the first analysis. Patient age at the time of rupture was compared with risk factors.

### RAAA and aneurysm size

In the second analysis, to ensure reliable and reproducible measurement of AAA diameter, only patients who underwent computed tomography (CT) imaging confirming a ruptured AAA were selected. CT images demonstrating rupture were reviewed and the maximum AP diameter (outer to outer) was measured. The diameter data were compared with the information of patient risk factors collected from the local vascular registries and patient records.

## Statistical methods

Statistical analysis was done using SPSS Statistics (IBM, Armonk, NY, USA). Univariate analysis between age and risk factor data and AP diameter and risk factor data was performed with independent samples *t* test. Multivariate analysis was performed using a logistic regression model with aneurysm size under 55 mm and age under 65 years as dependent factors. The risk factors associated with patient age that had  $p < .2$  in univariate analysis were selected for the multivariate model to identify risk factors independently predicting a rupture before the age of 65 years, which is commonly used in screening programs. The maximal AP diameter in relation to the risk factor data was included in a univariate analysis. All risk factors with  $p < .2$  were included in the multivariate model to see which risk factors were associated with rupture before reaching 55 mm diameter. How well the threshold for elective aneurysm repair covered RAAA patients was also calculated.

In the cases where the registry data were incomplete, the missing data were acquired from patient records. After completing the data from the case records, the smoking data were available in 71% of the cases. If patients had smoked actively during the past 5 years they were considered to be smokers. If they had never smoked or had quit smoking over 5 years before, they were considered to be non-smokers. Thus many patients labeled as non-smokers actually had a very long history of smoking.

## RESULTS

### RAAA and patient age

Altogether, 587 RAAA patients, 16.9% of whom were women, were admitted to HUH and TaUH between 2002–

**Table 1.** Patient demographics in relation to gender. \* indicates  $p < .05$ .

|                     | Men         | Women      | Total      | Missing | <i>p</i> |
|---------------------|-------------|------------|------------|---------|----------|
| <i>N</i>            | 486 (83.1%) | 99 (16.9%) | 585        |         |          |
| Mean age            | 72.2 (9.3)  | 80.7 (7.6) | 73.6 (9.5) |         | <.01*    |
| (SD)                |             |            |            |         |          |
| Smoking             | 183         | 25         | 208        | 169     | .1       |
|                     | 37.7%       | 25.3%      | 35.6%      | 28.9%   |          |
| Coronary disease    | 211         | 52         | 263        | 19      | .06      |
|                     | 43.4%       | 52.5%      | 45.0%      | 3.2%    |          |
| Diabetes            | 55          | 12         | 67         | 4       | .81      |
|                     | 11.3%       | 12.1%      | 11.5%      | 0.7%    |          |
| Hypertension        | 261         | 59         | 320        | 29      | .21      |
|                     | 53.7%       | 59.6%      | 54.7%      | 5.0%    |          |
| Pulmonary disease   | 108         | 23         | 131        | 27      | .57      |
|                     | 22.2%       | 23.2%      | 22.4%      | 4.6%    |          |
| Previous stroke/TIA | 83          | 12         | 95         | 20      | .27      |
|                     | 17.1%       | 12.1%      | 16.2%      | 3.4%    |          |
| Dyslipidemia        | 147         | 30         | 177        | 76      | .77      |
|                     | 30.2%       | 30.3%      | 30.3%      | 13.0%   |          |
| CT scan             | 267         | 61         | 328        |         | .22      |
|                     | 54.9%       | 61.6%      | 56.1%      |         |          |

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