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Ultrasound surveillance of ectatic abdominal aortas

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ABSTRACT

INTRODUCTION Some studies have considered abdominal aortas of 2.6–2.9 cm diameter (ectatic aortas) at age 65 years as being abnormal and have recommended surveillance, whereas others have considered these normal and surveillance unnecessary. It is, therefore, not clear how to manage patients with an initial aortic diameter between 2.6–2.9 cm detected at screening. The aim of this study was to evaluate growth rates of ectatic aortas detected on initial ultrasound screening to determine if any developed into clinically significant abdominal aortic aneurysms (AAAs; > 5.0 cm) and clarify the appropriate surveillance intervals for these patients.

PATIENTS AND METHODS Data were obtained from a prospective AAA screening programme which commenced in 1992. The group of patients with initial aortic diameters of 2.6–2.9 cm with a minimum of 1-year follow-up were included in this study (Group 2). This was further divided into two subgroups (Groups 3a and 3b) based on a minimum follow-up interval obtained from outcome analysis. Mean growth rate was calculated as change in aortic diameter with time. The comparison of growth rates in Groups 3a and 3b was performed using the *t*-test. The number and proportion of AAAs that expanded to ≥ 3.0 cm and ≥ 5.0 cm in diameter were also calculated.

RESULTS Out of 999 patients with AAA ≥ 2.6 cm with minimum 1-year follow-up, 358 (36%) were classified as ectatic aortas (2.6–2.9 cm) at initial ultrasound screening with the mean growth rate of 1.69 mm/year (95% CI, 1.56–1.82 mm/year) with a mean follow-up of 5.4 years. Of these 358 ectatic aortas, 314 (88%) expanded into ≥ 3.0 cm, 45 (13%) expanded to ≥ 5.0 cm and only 8 (2%) expanded to ≥ 5.5 cm over a mean follow-up of 5.4 years (range, 1–14 years). No ectatic aortas expanded to ≥ 5.0 cm within the first 4 years of surveillance. Therefore, the minimum follow-up interval was set at 4 years and this threshold was then used for further analysis. The mean growth rate in Group 3a (< 5.0 cm at last scan) was 1.33 mm/year (95% CI, 1.23–1.44 mm/year) with a mean follow-up of 7 years compared to Group 3b (≥ 5.0 cm at last scan) with the mean growth rate of 3.33 mm/year (95% CI 3.05–3.61 mm/year) and a mean follow-up of 8 years. The comparison of mean growth rates between Groups 3a and 3b is statistically significant (*t*-test; T = 13.00; $P < 0.001$).

CONCLUSIONS One-third of patients undergoing AAA screening will have ectatic aortas (2.6–2.9 cm) and at least 13% of these will expand to a size of ≥ 5.0 cm over a follow-up of 4–14 years. A threshold diameter of 2.6 cm for defining AAAs in a screening programme is recommended and ectatic aortas detected at age 65 years can be re-screened at 4 years after the initial scan. A statistically significant difference was found in the growth rates of ectatic aortas with minimum 4 years follow-up, expanding to ≥ 5.0 cm compared to those less than 5.0 cm at last surveillance scan. Further studies are required to test the hypothesis of whether growth rate over the first 4 years of surveillance will identify those who are most likely to expand to a clinically significant size (> 5.0 cm).

KEYWORDS

Ectatic aorta – Surveillance – Growth rates – Abdominal aortic aneurysm – Ultrasound

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Ruptured abdominal aortic aneurysm (AAA) accounts for about 2% of all deaths in men older than 65 years.[1] Several randomised controlled trials have shown that ultrasound screening and planned elective surgical treatment significantly reduces AAA-related mortality in men aged 65–74 years[1–3] and is cost effective.[4,5] Operative intervention is recommended in AAA larger than 5.5 cm,[6] but the majority of the AAAs detected by screening are classified as small (*i.e.* less than 5.5 cm in diameter). Randomised controlled trails have shown that surgical repair of small AAAs does not confer any additional survival advantage over periodic ultrasound surveillance.[7,8]

Although in many screening trials AAA is defined as maximal aortic diameter of ≥ 3 cm, in many patients the

measurements at initial screening are between 2–3 cm. Patients with an aortic diameter of less than 2.6 cm at age 65 years have a very low risk of developing into clinically significant aneurysms and do not justify continued ultrasound surveillance.[9]

Some studies have considered abdominal aortas of diameter 2.6–2.9 cm (ectatic aortas) at age 65 years as being abnormal and have recommended surveillance,[10–12] whereas others have considered these normal and surveillance unnecessary.[13,14] There is no clear guidance on whether ectatic aortas justify surveillance at all, what the optimal intervals are and when to stop. It is, therefore, not clear how to manage patients with an initial aortic diameter between 2.6–2.9 cm detected at screening.

The aim of this study was to evaluate growth rates of ectatic aortas detected on initial ultrasound screening to determine if any developed into clinically significant AAA (> 5.0 cm) and clarify the appropriate surveillance intervals for these patients.

Patients and Methods

Data were obtained from the AAA screening programme, which commenced in 1992 at Good Hope Hospital NHS Trust, West Midlands, UK. The target population was 450,000 but there was not complete coverage of that population and inclusion was voluntary. Men aged 65–75 years were invited to attend ultrasound screening; thereafter, screening was offered to all males reaching their 66th year. Those with anterioposterior (AP) diameter greater than 2.5 cm were classified as abnormal and offered continued surveillance (Group 1). Surveillance intervals ranged from 1 year for AAA 2.6–4.0 cm, 6 months for AAA 4.0–5.0 cm and 3 months for AAA ≥ 5.0 cm. Operative intervention was considered in patients with AAA ≥ 5.5 cm.

The group of patients with ectatic aortas (2.6–2.9 cm in diameter) at first scan, with a minimum 1-year follow-up were included in this study (Group 2). Analysis of the outcome in this group was performed to determine the safe minimum follow-up interval. From this group, ectatic aortas with the minimum follow-up interval were selected (Group 3) and further divided into two subgroups – Group 3a, ectatic aortas < 5.0 cm in diameter at last scan; and Group 3b, ectatic aortas ≥ 5.0 cm in diameter at last scan.

The average growth rate was calculated as the change in aortic diameter over time, using the formula:

$$\text{Rate of growth (mm/year)} = \frac{[\text{AP diameter at last scan} - \text{AP diameter at first scan}]\ (\text{mm})}{\text{Time interval (years)}} \quad \text{Eq. 1}$$

The comparison of growth rates in Groups 3a and 3b was performed using the *t*-test. The number and proportion of AAAs that expanded to ≥ 3.0 cm and ≥ 5.0 cm in diameter were also calculated.

Table 1 Group 1: all patients with aortic diameters ≥ 2.6 cm at initial scan with minimum 1-year follow-up

Total number (*n*)	999
Mean growth rate	1.73 mm/year (0.0–6.67 mm/year)
+95% CI	1.82 mm/year
–95% CI	1.56 mm/year
Mean age at last scan	74.75 years (63.2–87.1 years)
Mean follow-up	5.43 years (1–14 years)
Mean size at first scan	2.8 cm (2.5–2.9 cm)
Mean size at last scan	3.8 cm (2.6–6.0 cm)

Ranges are given in parentheses.

Results

There were 999 patients with AAA ≥ 2.6 cm with minimum 1-year follow-up (Table 1). Of these, 358 (36%) were classified as ectatic aortas (2.6–2.9 cm) at initial ultrasound screening (Group 2; Table 2) and the mean growth rate was 1.69 mm/year (95% CI 1.56–1.82 mm/year with a mean follow-up of 5.4 years (Table 2). Of the 358 patients with ectatic aortas, 314 (88%) expanded into ≥ 3.0 cm, 45 (13%) expanded to ≥ 5.0 cm and only 8 (2%) expanded to ≥ 5.5 cm over a mean follow-up 5.4 years (range, 1–14 years; Table 3).

No ectatic aortas expanded to ≥ 5.0 cm within the first 4 years of surveillance (Fig. 1). Therefore, the minimum follow-up interval was set at 4 years and this threshold was then used for further analysis (Fig. 2).

Table 2 Group 2: ectatic aortas 2.6–2.9 cm at first scan with a minimum 1-year follow-up

Total number (*n*)	358
Mean growth rate	1.69 mm/year (0.0–6.67 mm/year)
+95% CI	1.82 mm/year
–95% CI	1.56 mm/year
Mean age at last scan	74.6 years
Mean follow-up	5.4 years (1–14 years)
Mean size at first scan	2.8 cm (2.6–2.9 cm)
Mean size at last scan	3.7 cm (2.6–6.0 cm)

Ranges are given in parentheses

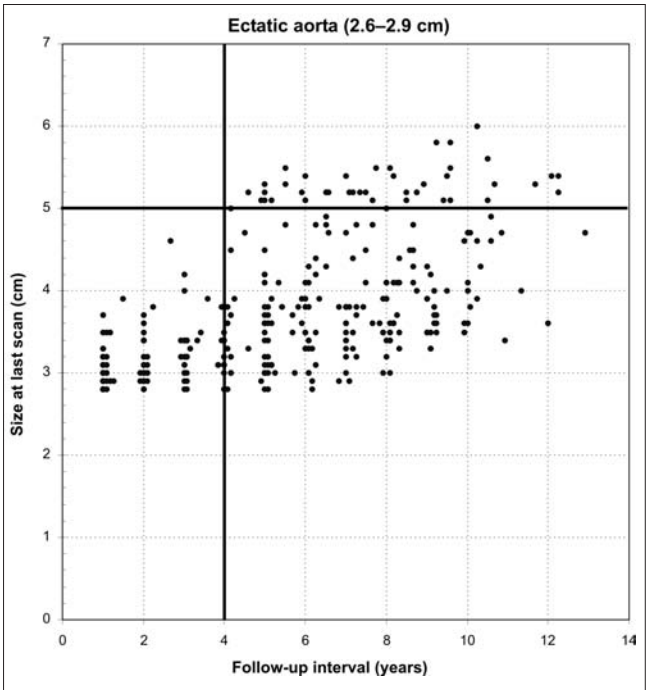

Figure 1 Scattergram.

Group 3 consisted of 239 patients with ectatic aortas and a minimum of 4 years' follow-up (Table 4). Group 3a (< 5.0 cm at last scan) consisted of 194 (82%) patients and Group 3b (≥ 5.0 cm at last scan) consisted of 45 (18%) patients (Fig. 2).

The mean growth rate in Group 3a was 1.33 mm/year (95% CI, 1.23–1.44 mm/year) with a mean follow-up of 7 years compared to Group 3b with the mean growth rate of 3.33 mm/year (95% CI, 3.05–3.61 mm/year) and a mean follow-up of 8 years (Tables 5 and 6). The comparison of mean growth rates between Groups 3a and 3b is statistically significant (*t*-test; T = 13.0; $P < 0.001$).

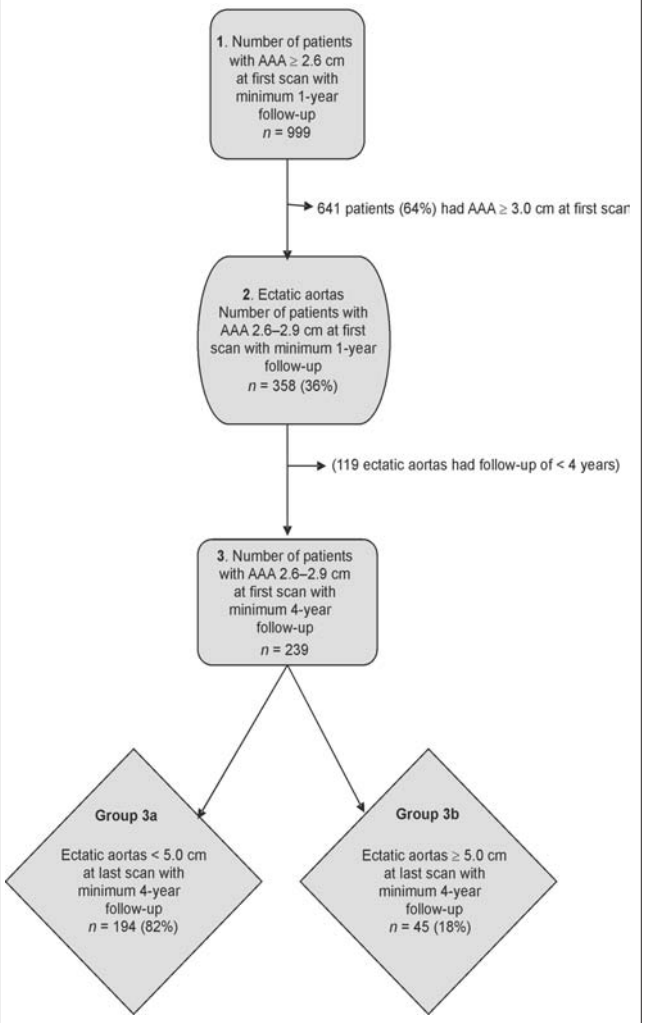

Figure 2 Flow chart of results.

Discussion

An AAA screening programme will identify a considerable number of patients with small AAA < 5.5 cm[1] who require

Table 3 Number and proportion of ectatic aortas expanding to ≥ 3.0 cm and ≥ 5.0 cm at last scan

Ectatic aortas	*n*	Proportion of all ectatic aortas
Diameter ≥ 3.0 cm at last scan	314	88%
Diameter ≥ 5.0 cm at last scan	45	12.5%
Diameter ≥ 5.5 cm at last scan	8	2%

Table 4 Group 3: ectatic aortas (2.6–2.9 cm) at first scan with a minimum of 4 years' follow-up

Total number (*n*)	239
Mean growth rate	1.71 mm/year (0.0–5.75 mm/year)
+95% CI	1.85 mm/year
–95% CI	1.57 mm/year
Mean age at last scan	76.2 years
Mean follow-up	7.2 years (1–14 years)
Mean size at first scan	2.8 cm (2.6–2.9 cm)
Mean size at last scan	4.0 cm (2.6–6.0 cm)

Ranges are given in parentheses.

Table 5 Group 3a: ectatic aortas less than 5.0 cm at last scan with a minimum of 4 years' follow-up

Total number (*n*)	194
Mean growth rate	1.33 mm/year (0.0–4.0 mm/year)
+95% CI	1.44 mm/year
–95% CI	1.23 mm/year
Mean age at last scan	76.0 years
Mean follow-up	7.0 years (4–14 years)
Mean size at first scan	2.8 cm (2.6–2.9 cm)
Mean size at last scan	3.7 cm (2.6–4.9 cm)

Ranges are given in parentheses.

Table 6 Group 3b: ectatic aortas ≥ 5.0 cm at last scan with a minimum of 4 years' follow-up

Total number (*n*)	45
Mean growth rate	3.33 mm/year (2.0–5.8 mm/year)
+95% CI	3.61 mm/year
–95% CI	3.05 mm/year
Mean age at last scan	76.6 years
Mean follow-up	8.0 years (4–12.3 years)
Mean size at first scan	2.8 cm (2.6–2.9 cm)
Mean size at last scan	5.3 cm (5.0–6.0 cm)

Ranges are given in parentheses.

periodic ultrasound surveillance.[7,8] Some studies have shown that ectatic aortas (2.6–2.9 cm) constitute a substantial proportion of small AAAs identified at screening and justify surveillance.[10,12,15,16] Other reports consider ectatic aortas as insignificant and conclude that surveillance is unnecessary in this group of patients.[14,17]

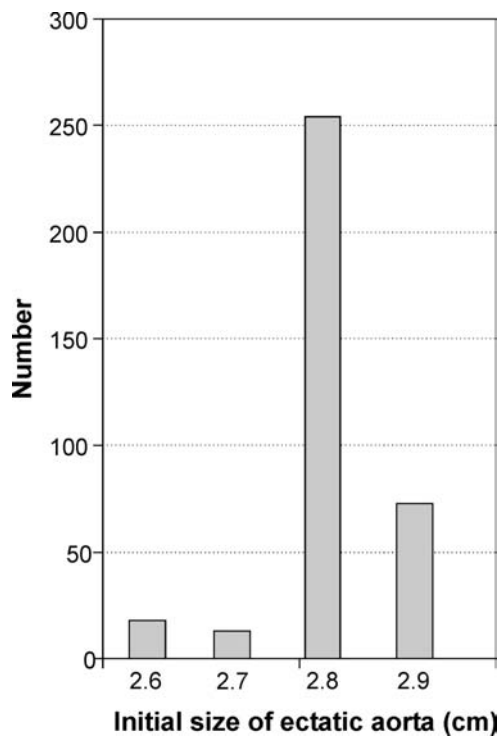

Figure 3 Distribution of ectatic aortas by size.

In the Gloucester study, 625 (43%) of all AAAs detected at initial screening were ectatic (2.6–2.9 cm) and 2.4% expanded to ≥ 5.5 cm over 5 years and 13.8% expanded to > 5.5 cm over 10 years of follow-up (10). In a study of 223 ectatic aortas by d'Audiffret *et al.*,[15] 63% developed into true aneurysms and 1.8 % expanded into > 5.0 cm in diameter with a mean follow-up of 5.9 years. The findings in this present study are consistent with previous reports that ectatic aortas comprise of about one-third of AAAs detected at screening. The results from this study show that about 13% of ectatic aortas will expand to > 5.0 cm and 2% expand to ≥ 5.5 cm over a mean follow-up of 5.4 years (range, 1–14 years) and, therefore, support surveillance in this patient group.

Previous studies of ectatic aortas reported growth rates ranging from 0.7 to 1.3 mm/year (Table 7). In the present study of 358 patients with ectatic aortas, the mean growth rate of 1.69 mm/year is slightly greater than previous reports. In addition, 88% of ectatic aortas in this study expanded to true aneurysms, which is also higher than previous reports. This difference could be due to the skewed distribution of ectatic aortas towards larger diameters observed in this study (Fig. 3).

None of the ectatic aortas in this study expanded to a size of ≥ 5.0 cm in the first 4 years of surveillance (Fig. 1). Hence, a first surveillance interval of 4 years appears to be reasonable and safe, a finding consistent with previous studies (Table 7).

One limitation of this study compared with others is the lack of data on outcomes and mortality in the study group. Previous studies of small AAAs have shown that the risk of rupture of AAAs < 5.5 cm is less than 1% per year.[7,8] In addition, it is possible that a proportion of these ectatic aortas may be false negatives representing small aneurysms because of the 2–5 mm variation in the measurement of AAAs by ultrasound scan. Lindholt *et al.*[12] also pointed out

Table 7 Growth rates and surveillance intervals of ectatic aortas

Reference	Number of patients	Growth rate (mm/year)	Surveillance interval (years)
McCarthy *et al.*[10]	625	0.9	5
Lindholt *et al.*[12]	348	0.7	5
d'Audiffret *et al.*[15]	223	1.3	5
Basnyat *et al.*[16]	116	0.65	3

that there is a tendency at initial scans to define these ectatic aortas just below 3 cm as true aneurysms to make sure that no AAAs are missed.

Some studies have suggested that small AAAs may be classified as fast and slow growing,[16,18] but presented no evidence of clear criteria to differentiate between the two groups. Vardulaki *et al.*[15] compared the actual observed aortic diameters with the estimated aortic diameters by fitted growth curves and suggested that AAAs grow exponentially; however, the results were very similar if a linear pattern of growth was assumed. In this study, we have compared the linear growth rates of ectatic aortas that expanded to ≥ 5.0 cm (Group 3b) with those less than 5.0 cm (Group 3a) at last scan with a minimum of 4 years of follow-up, to distinguish between fast and slow rate of growth. A significant difference was noted in the growth rates of ectatic aortas reaching ≥ 5.0 cm in diameter (3.33 mm/year) compared to those less than 5.0 cm at last scan (1.33 mm/year). Although the mean follow-up duration of Groups 3a and 3b are different, it is unlikely, given the 4-fold difference in average growth rate, that a 1 year difference in mean follow-up would affect this. Further analysis of patterns of growth in different patients will clarify this but it is beyond the scope of this study. This suggests that, for ectatic aortas under surveillance, the measured growth rate at 4 years might be used as a predictor of which may expand to a clinically significant size of 5.0 cm and may, therefore, be used to formulate appropriate surveillance intervals. Further study is necessary to test the hypothesis of whether growth rate at 4 years accurately predicts an individual patient's future rate of growth and the probability of developing into a clinically significant AAA. Studies have shown that certain factors such as smoking, hypertension and matrix metalloproteinase (MMP) levels influence the growth rate of AAAs.[19–21] Further research into these molecular, geometric and biomechanical factors using multivariate analysis might show these to be independent predictors of faster growth rate; this would be worth further study, as growth rate of ectatic aortas seems to be a sensitive indicator.

Conclusions

One-third of patients undergoing AAA screening will have ectatic aortas (2.6–2.9 cm) and at least 13% of these will expand to a size of ≥ 5.0 cm over a follow-up of 4–14 years. A threshold diameter of 2.6 cm for defining AAAs in a screening programme is recommended and ectatic aortas detected at age 65 years can be re-screened at 4 years after the initial scan. A statistically significant difference was found in the growth rates of ectatic aortas with minimum 4 years of follow-up, expanding to ≥ 5.0 cm compared to those less than 5.0 cm at last surveillance scan. Further studies are required to test the hypothesis of whether growth rate over the first 4 years of surveillance will identify those who are most likely to expand to a clinically significant size (> 5.0 cm).

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