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Trend-break in Abdominal Aortic Aneurysm Repair With Decreasing Surgical Workload

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WHAT THIS PAPER ADDS

The present study adds knowledge about recent trends in abdominal aortic aneurysm (AAA) epidemiology in the light of the introduction of endovascular management, screening, and decreasing AAA prevalence. It describes a marked decrease in ruptured AAA repair rate, a stabilization of intact AAA repair rate and ever improving survival rates.

Background: The epidemiology and management of abdominal aortic aneurysms (AAAs) has changed drastically in the past decades, with implementation of nationwide screening programs, introduction of endovascular repair (EVAR), and reduced prevalence of the disease. This report aims to assess recent trends in AAA repair epidemiology in Sweden in this context.

Methods: Primary AAA repairs registered in the nationwide Swedish Vascular Registry (Swedvasc) 1994–2014 were analyzed regarding patient characteristics, repair incidence, technique, and outcome. Four time periods were compared: 1994–1999, 2000–2004, 2005–2009, and 2010–2014.

Result: The incidence of intact AAA repair increased (18.4/100,000 1994–1999, 27.3/100,000 2010–2014, $p < .001$) predominantly among octogenarians (12.7/100,000 1994–1999, 36.0/100,000 2010–2014, $p < .001$). The utilization of EVAR increased (58% of all intact AAA repairs 2010–2014), especially among octogenarians (80% 2010–2014). During the last time period, however, the incidence of intact AAA repair stabilized, despite an increasing number of screening-detected AAAs operated on (19% in 2010–2014). Short- and long-term outcome after intact AAA repair continued to improve, most pronounced among octogenarians (30-day mortality 9% 1994–1999, 2% 2010–2014, $p < .001$). The incidence of ruptured AAA repair steadily decreased (9.2/100,000 1994–1999, 6.9/100,000 2010–2014, $p < .001$) and the use of EVAR for ruptures increased (30% in 2010–2014). The previously observed improvement of short- and long-term outcome after ruptured AAA repair (30-day mortality 38% 1994–1999, 28% 2010–2014, $p < .001$) stalled during the last time period. The overall 30-day mortality after ruptured AAA repair was 22% after EVAR versus 31% after open repair in 2010–2014. The corresponding mortality for octogenarians was 28% versus 42%.

Conclusions: For the first time, a halt in intact AAA repair workload could be identified. This trend-break occurred despite continued increase in treatment of octogenarians and screening-detected aneurysms. Additionally, the ruptured AAA repair incidence continued to decrease. These findings, together with the sustained improvement in survival after AAA repair, may have important impact on planning of vascular surgical services.

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INTRODUCTION

In the past two decades important changes in the epidemiology and treatment of abdominal aortic aneurysms (AAAs) have occurred. The introduction of endovascular aortic repair (EVAR)[1,2] has made it possible to offer surgical treatment to patients who are not optimal candidates for open aortic repair (OR).[3,4] With improved perioperative care[5] and centralization of AAA interventions,[6] outcome has steadily improved.[7,8] Screening for AAA has been proven effective from a clinical and health economic perspective,[9,10] and a screening program targeting 65-year-old men was introduced in Sweden in 2006,[11] reaching nationwide coverage in 2015.[12] Similar programs were launched in the UK and United States.[13] Furthermore, the prevalence of the disease has fallen, partly because of changing smoking habits.[14]

These changes affect the epidemiology of AAA repair, which have implications on patient care and the optimal

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provision of vascular surgical services. The Swedish vascular registry (Swedvasc), with its high validity,[15,16] in combination with the Swedish Population Registry, which provides 100% accurate mortality data, offers a great opportunity to monitor AAA repair epidemiology on a national level.

The aim of this paper was to study the AAA repair epidemiology in Sweden 1994–2014, with focus on recent trends.

MATERIALS AND METHODS

All primary AAA interventions performed during the period 1994–2014 were identified in the Swedvasc registry. Re-do procedures, duplicate entries, patients without a Swedish personal identification number (PIN), and patients <50 years of age were excluded. Data were cross-checked for mortality against the Swedish Population Registry in August 2015.

Preoperative comorbidities registered in Swedvasc were diabetes (treated by diet, per oral medication, or insulin), pulmonary disease (any diagnosed pulmonary disease), cerebrovascular disease (stroke or transient ischemic attack), renal impairment (serum creatinine $\geq$ 150 mmol/L or renal replacement therapy), and heart disease (history of myocardial infarction, angina pectoris, heart failure, coronary bypass surgery, heart valve surgery, or atrial fibrillation). After May 2008, atrial fibrillation was not considered a cardiac comorbidity in Swedvasc. A nationwide AAA screening program targeting 65-year-old men was gradually introduced in Sweden 2006–2015. From 2010 it is recorded in Swedvasc if an AAA undergoing repair is detected by screening. Data were extrapolated and assumed a linear increase in screening-detected AAAs operated on from 2006 to 2010.

Intact AAA repair was defined as any AAA operated on without any signs of rupture regardless of elective or urgent repair. Data for intact AAA and ruptured AAA were analyzed separately. Based on a predefined protocol for data analysis, data were calculated overall and for three age subgroups (50–64 years, 65–79 years, and $\geq$ 80 years), and for four time periods (1994–1999, 2000–2004, 2005–2009, and 2010–2014). Age- and sex-specific population data for each subgroup and overall (Swedish population $\geq$ 50 years) were obtained from Statistics Sweden.[17]

Statistical analysis

Proportions were compared using the chi-square test. Changes in proportions over time were assessed using the chi square test for trend. Normally distributed data were compared using one-way ANOVA. Histograms were used to assess normality. Long-term survival was calculated using Kaplan–Meier analysis and the log rank test was used to compare groups. To compensate for multiple testing $p < .010$ was considered significant. Ninety-nine percent confidence intervals (CI) for proportions were calculated with the Wald approximation. Calculations were made using SPSS version 22.0 (IBM, Armonk, NY, USA) and GraphPad Prism 6 (Graphpad software, La Jolla, CA, USA).

Ethics approval

The study was approved by the Regional Ethics Board of Uppsala (2014/078) and by the Swedvasc review board. According to the rules of the Swedvasc registry, informed consent is required from each patient or relative prior to registration, except for fatal cases that are exempted from informed consent according to Swedish law.

RESULTS

A total of 15,268 intact AAA repairs and 5,907 ruptured AAA were identified. The repair incidence was 21.9 per 100,000 $\geq$ 50 years for intact AAA, and 8.5 per 100,000 for ruptured AAA. Baseline characteristic are shown in Table 1 and 30-day mortality in Table 2.

Intact AAA repair

The incidence of intact AAA repair increased by 48.5% (99% CI 41.1–55.8) from the first to the last study period. The increase in intact AAA repair incidence was significant in all age groups ($p < .001$; see Fig. 2 and Table 1). The increase was most prominent among octogenarians where repair incidence inclined 184% (99% CI 144.8–223.5) from 12.7 out of 100,000 $\geq$ 80 years in 1994–1999 to 36.0 out of 100,000 $\geq$ 80 years in 2010–2014. However, during the last time period the repair incidence stabilized (incidence 2010–2014 chi square for trend $p = .062$). During the same period, an increasing number of screening-detected AAAs were operated on, constituting 18.6% (99% CI 17.2–20.1) of all intact AAA repairs during the last period (Fig. 1). The proportion of repairs performed with EVAR increased continuously (Fig. 2, Appendix I) from 3.4% (99% CI 2.6–4.2) 1994–1999 to 57.5% (99% CI 55.7–59.3) in 2010–2014. For patients $\geq$ 80 years EVAR was used in 79,7% (99% CI 76.3–83.2) of intact AAA repair in 2010–2014.

Despite progressively older patients, short- and long-term outcome improved over time, most prominent among octogenarians (Tables 1–3). Although 30-day mortality in octogenarians was two to three times higher than in younger patients during the first three time periods, there was no remaining difference between age groups in the last time period (Table 2) ($p = .246$). The prevalence of current smokers decreased and the comorbidity spectrum changed significantly; with fewer patients having a history of heart disease, and more patients were being treated for hypertension and having a history of diabetes, and pulmonary disease (Tables 1 and 2).

Ruptured AAA repair

During the second half of the study period the ruptured AAA repair incidence decreased significantly overall, among men and among patients < 80 years ($p < .001$), but was stable among women. For octogenarians there was a significant increase in repair incidence ($p = 0.007$). The utilization of EVAR slowly increased over time, most prominent in the $\geq$ 80 years group ($p < .001$) (Figs 1 and 2, Table 1, and Appendix I).

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