European Journal of Vascular and Endovascular Surgery 43 (2012) 43–47

Contents lists available at SciVerse ScienceDirect

European Journal of Vascular and Endovascular Surgery

journal homepage: www.ejves.com

Preoperative Spirometry Results as a Determinant for Long-term Mortality after EVAR for AAA

T. Ohrlander[a], M. Dencker[c], S. Acosta[b,*]

[a] Eksjö County Hospital, Eksjö, Sweden
[b] Vascular Center Malmö-Lund, Skåne University Hospital, Malmö, Sweden
[c] Department of Clinical Physiology and Nuclear Medicine, Skåne University Hospital, Malmö, Sweden

WHAT THIS PAPER ADDS

- The study strengthens the need for formal evaluation of lung function with spirometry before selection for elective EVAR of AAA.

ARTICLE INFO

Article history:
Received 18 July 2011
Accepted 29 September 2011
Available online 2 November 2011

Keywords:
EVAR
Lung function
Spirometry
Arterial blood gas
Mortality

ABSTRACT

Objectives: The aim of this study was to analyse lung function test determinants for long-term mortality after standard endovascular aneurysm repair (EVAR) for infrarenal abdominal aortic aneurysm (AAA).
Design: Retrospective analysis.
Materials: Three-hundred and four consecutive patients treated electively with EVAR (Zenith® stent grafts, Cook) between May 1998 and February 2006 were prospectively enrolled in a computerised database.
Methods: The Global Initiative for Chronic Obstructive Lung Diseases (GOLD) guideline was used to grade the severity of obstructive lung disease. Mortality was checked until 1 December 2010. Median follow-up time was 68 (interquartile range (IQR) 40–94) months.
Results: The percentage of patients with mild, moderate or severe (grade 3) chronic obstructive pulmonary disease (COPD) was 9.9%, 23.2% and 7.7%, respectively. In a combined medical severity assessment, arterial partial pressure of oxygen (PaO_2) < 8.0 kPa or COPD, grade ≥3 (hazard ratio (HR) 2.06; 95% confidence interval (CI) (1.24–3.42)), anaemia (HR 1.72; 95% CI (1.21–2.44)), chronic kidney disease, stage ≥3 (HR 1.55; 95% CI (1.08–2.24)) and age ≥80 years (HR 1.55; 95% CI (1.04–2.31)) were independently associated with long-term mortality. Lower forced expiratory volume in 1 s (FEV_1) ($p = 0.002$) and lower forced vital capacity (FVC) ($p = 0.003$) were independently associated with long-term mortality.
Conclusions: Our findings strengthen the need for formal evaluation of lung function with spirometry prior to proceeding to AAA repair.

Development of abdominal aortic aneurysm (AAA) and chronic obstructive pulmonary disease (COPD) are both strongly related to the effects of smoking, and both disorders may be present simultaneously: The prevalence of AAA among patients with COPD has been estimated to be around 10%[1] and the prevalence of COPD among AAA patients has been found to be above 55%.[2] In comparison with AAA, COPD is a far more serious disease in terms of morbidity, health-care resources and mortality: COPD affected 210 million people worldwide and caused over 3 million deaths globally in 2005 (5% of all deaths), recognised as the fourth leading death cause in the world.[3]

In this context, preoperative assessment of lung function should be standardised and equally important as evaluation of cardiac function. However, there are reports indicating that the presence or absence of COPD, and the severity of COPD, seems to be a factor that is often overlooked in the preoperative assessment.[4,5] Patients who are not assessed by spirometry prior to intervention for their AAA

* Corresponding author. S. Acosta, Vascular Center Malmö-Lund, Skåne University Hospital, SE-205 02 Malmö, Sweden. Tel.: +46 455731000; fax: +46 455734483.
E-mail address: stefan.acosta@telia.com (S. Acosta).

1078-5884/$ – see front matter
doi:10.1016/j.ejvs.2011.09.028

are most likely not diagnosed.[4,6] Indeed, the severity of COPD is seldom included in risk factor analysis. Hence, COPD is an under-diagnosed and under-reported risk factor in patients with AAA.

Spirometry and arterial blood gas analysis prior to either open or endovascular repair of AAA have, in our institution, been a standard for evaluation of lung function. However, the prognostic capacity of each specific lung function parameter and the severity of COPD on long-term all-cause mortality are unclear. The aim of this study was to analyse lung function test determinants for long-term mortality after standard endovascular aneurysm repair (EVAR) with the Zenith® bifurcated stent graft for infrarenal AAA.

Methods

Patients

The Vascular Center, Malmö-Lund, is a tertiary referral centre for patients with vascular disease. This study comprised consecutive patients who underwent elective, non-fenestrated EVAR (Zenith® stent grafts (Cook Europe A/S, Bjaeverskov, Denmark)) for infrarenal non-ruptured AAA between May 1998 and February 2006. The patients were identified in the prospective database for endovascular interventions. Complementary data were retrieved from patient records.

EVAR

In general, anatomical suitability for EVAR included proximal neck diameter $\leq$30 mm, angulation $\leq$90° and length $\geq$12 mm. For distal implantation, at least one common iliac artery with a distal diameter $\leq$20 mm was required. The procedure was performed exclusively with percutaneous technique in 47% of the cases by using percutaneous closure devices at the femoral access sites.

Spirometry

Spirometry was performed according to the standards of the European Respiratory Society.[7] A spirometer (Mirolab 3000 or EasyOne) was used under the supervision of a physiotherapist, employed at the Vascular Center, to measure forced expiratory volume in 1 s (FEV_1) and forced vital capacity (FVC). FEV_1% was defined as FEV_1 in relation to predicted normal FEV_1 and FVC% as FVC in relation to predicted normal FVC.[8–10] Chronic obstructive pulmonary disease (COPD) was present if $FEV_1/FVC < 70\%$ (<65 years) or $FEV_1/FVC < 65\%$ ($\geq$65 years). The Global Initiative for Chronic Obstructive Lung Diseases (GOLD) guidelines was used to grade (stage) the severity of obstructive lung disease:[11] Grade 0: $FEV_1/FVC \geq 0.70$ and $FEV_1 \geq 80\%$ predicted value and symptoms of chronic bronchitis. Grade 1 (mild): $FEV_1/FVC < 0.70$ and $FEV_1 \geq 80\%$ predicted value. Grade 2 (moderate): $FEV_1/FVC < 0.70$ and $FEV_1 < 80\%$ predicted value and $FEV_1 \geq 50\%$ predicted value. Grade 3 (severe): $FEV_1/FVC < 0.70$ and $FEV_1 < 50\%$ predicted value and $FEV_1 \geq 30\%$ predicted value. Grade 4 (very severe): $FEV_1/FVC < 0.70$ and $FEV_1 < 30\%$ predicted value.

Arterial blood gas test

Arterial blood gas was sampled at rest at the Department of Clinical Physiology, analysed and respiratory failure was considered present if the arterial partial pressure of oxygen (PaO_2) < 8.0 kPa (60 mmHg), with or without an arterial partial pressure of carbon dioxide ($PaCO_2$) > 6.7 kPa (50 mmHg), while breathing air at sea level.[12] A pathological blood gas test was present if $PaO_2 < 9.4$ kPa or $PCO_2 > 6.3$ kPa.

Evaluation of renal function

The Cockroft–Gault formula includes serum creatinine, age, weight and gender to calculate glomerular filtration rate (GFR).[13] Stages of chronic kidney disease were determined on GFR levels and the National Kidney Foundation guidelines.[14] Stage I is defined as GFR > 90 ml min^{-1} 1.73 m^{-2} (normal or increased GFR), stage II (GFR 60–89 ml min^{-1} 1.73 m^{-2}, small decrease in GFR), stage III (GFR 30–59 ml min^{-1} 1.73 m^{-2}, moderate decrease in GFR), stage IV (GFR 15–29 ml min^{-1} 1.73 m^{-2}, large decrease in GFR) and stage V (GFR < 15 ml min^{-1} 1.73 m^{-2}, need for dialysis, end-stage renal disease).

Other definitions

Hypertension was defined as systolic blood pressure >140 mmHg or diastolic blood pressure >90 mmHg, or both, at admission. Hypertension was also considered if the patient previously had been diagnosed with hypertension or was taking antihypertensive medication. Cerebrovascular disease was considered if there was a history of stroke (cerebral bleeding or infarction) or transient ischaemic attack (TIA). Ischaemic heart disease was considered if there was a history of myocardial infarction, angina pectoris, coronary artery bypass graft or percutaneous coronary angioplasty. Diabetes mellitus was noted if the patient had antidiabetic treatment with diet, oral hypoglycaemic agents or insulin.

Smoking included both current and former tobacco smokers. Anaemia was defined as haemoglobin <134 g l^{-1} in men and <117 g l^{-1} in women.

Follow-up

All patients were monitored from the day of EVAR until death or 1 December 2010. Median follow-up time was 68 months (interquartile range (IQR) 40–94). Follow-up mortality data were retrieved from the Swedish Population Registry. The causes of deaths (death certificates) were obtained from the National Board of Health and Welfare. This study was approved by the Research Ethics Committee at the University of Lund.

Statistical methods

Data management and statistical analysis were performed using SPSS 17.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as median and IQR. Differences in proportions were evaluated using the chi-square test or Kendall tau-b test. Comparisons between groups by using continuous variables were made with the Mann–Whitney *U* test. Correlations were calculated with the Spearman's rank test. Variables associated with death during follow-up in the univariate Cox regression analysis were further tested in a multivariate Cox regression model. Associations were expressed in terms of hazard ratios (HRs) with 95% confidence interval (CI) and *p*-values.

Survival analysis was performed according to the Kaplan–Meier method with Life table analysis. Log-rank test was used in the overall comparison of survival curves between patients with COPD, grade $\geq$2, and no COPD/COPD, grade 1. $p < 0.05$ was considered significant.

Results

Base line characteristics

Median age was 74 years (range: 53–89), and 43 (14%) were women. COPD was found in 95 out of those 233 patients