From the Eastern Vascular Society

Comparable perioperative mortality outcomes in younger patients undergoing elective open and endovascular abdominal aortic aneurysm repair

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ABSTRACT

Background: Evidence for benefit of endovascular aneurysm repair (EVAR) over open surgical repair for de novo infrarenal abdominal aortic aneurysms (AAAs) in younger patients remains conflicting because of heterogeneous study populations and small sample sizes. The objective of this study was to compare perioperative and short-term outcomes for EVAR and open surgery in younger patients using a large national disease and procedure-specific data set.

Methods: We identified patients 65 years of age or younger undergoing first-time elective EVAR or open AAA repair from the Vascular Quality Initiative (2003-2014). We excluded patients with pararenal or thoracoabdominal aneurysms, those medically unfit for open repair, and those undergoing EVAR for isolated iliac aneurysms. Clinical and procedural characteristics were balanced using inverse propensity of treatment weighting. A supplemental analysis extended the study to those younger than 70 years.

Results: We identified 2641 patients, 73% (n = 1928) EVAR and 27% (n = 713) open repair. The median age was 62 years (interquartile range, 59-64 years), and 13% were female. The median follow-up time was 401 days (interquartile range, 357-459 days). Unadjusted perioperative survival was 99.6% overall (open repair, 99.1%; EVAR, 99.8%; $P < .001$), with 97.4% 1-year survival overall (open repair, 97.3%; EVAR, 97.4%; $P = .9$). Unadjusted reintervention rates were five (open repair) and seven (EVAR) reinterventions per 100 person-years ($P = .8$). After propensity weighting, the absolute incidence of perioperative mortality was <1% in both groups (open repair, 0.9%, EVAR, 0.2%; $P < .001$), and complication rates were low. Propensity-weighted survival (hazard ratio, 0.88; 95% confidence interval, 0.56-1.38; $P = .6$) and reintervention rates (open repair, 6; EVAR, 8; reinterventions per 100 person-years; $P = .8$) did not differ between the two interventions. The analysis of those younger than 70 years showed similar results.

Conclusions: In this study of younger patients undergoing repair of infrarenal AAA, 30-day morbidity and mortality for both open surgery and EVAR are low, and the absolute mortality difference is small. The prior published perioperative mortality and 1-year survival benefit of EVAR over open AAA repair is not observed in younger patients. Further studies of long-term durability are needed to guide decision-making for open repair vs EVAR in this population. (J Vasc Surg 2018;67:1404-9.)

Endovascular aneurysm repair (EVAR) of abdominal aortic aneurysms (AAAs) has increasingly replaced open surgical repair as the standard of care for anatomically suitable candidates.[1,2] By 2006, EVAR utilization had risen to >70%[3] and continued at this rate through 2010.[4] EVAR has been shown to have a significant perioperative mortality and morbidity advantage that decreases over time,[5,6] especially among the elderly or those with significant comorbid conditions but even in acceptable-risk patients. However, this perioperative advantage may be less in lower risk populations, such as patients with fewer medical comorbidities or those of a younger age with longer life expectancies.[7]

EVAR has been shown to be potentially less durable compared with open repair over time, requiring more reinterventions and with a small but persistent risk of aneurysm rupture.[6,8] The declining effectiveness of EVAR over time may make open repair an acceptable alternative for younger patients if the perioperative morbidity and mortality risks in this population are

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comparable. Therefore, the objective of our study was to examine the perioperative and 1-year outcomes of younger patients receiving open repair or EVAR.

METHODS

This study of deidentified national registry data was approved by the Society for Vascular Surgery Patient Safety Organization Research Advisory Committee and our Institutional Review Board before data acquisition and analysis. This study was exempt from informed consent because of the deidentified nature of the data.

We identified and included patients 65 years of age or younger undergoing AAA repair using the Vascular Quality Initiative (VQI) EVAR and open repair registries from 2003 to 2014. We sought to compare only patients with AAAs that were amenable to either open repair or EVAR. In an attempt to approximate these parameters, exclusion criteria included any pararenal EVAR chimney or fenestrated operations as well as any open repairs involving suprarenal clamping and pararenal or thoracoabdominal aneurysms. Repairs performed for isolated iliac aneurysm were also excluded. To preserve the comparability of the two groups, EVAR patients who were deemed medically unfit for open repair as designated on the intake form by the operative surgeon were also excluded. For patients with multiple recorded AAA repairs in the database, the earliest repair was used as the index procedure.

The primary comparison groups were EVAR and open repair. Although these two procedures were recorded in two distinct registries, the outcome measure variables were consistent across both data sets. The primary outcome measures were in-hospital mortality and morbidity rates. Primary morbidity measures were myocardial infarction, respiratory failure (defined in the VQI registry as prolonged intubation), need for new-onset hemodialysis, and acute stroke. Biomarker-only elevations such as transient elevated troponin or creatinine elevation without clinical diagnosis of myocardial infarction or need for hemodialysis were not included as these may be subject to significant selection bias from differing baseline hospitalization courses of the two procedures. Secondary outcomes were reintervention rates over time and 1-year survival based on Social Security Death Index-linked death records present in the VQI data. Follow-up rates were limited to 1 year as institutional follow-up past 1 year is not required for participation in the VQI; those without follow-up were excluded from longitudinal analysis.

Propensity weighting was used to further balance and adjust for clinical and comorbid characteristics between the EVAR and open repair groups. The propensity for receiving EVAR vs open repair was fit using a logistic model and clinically relevant covariates. Covariates were included following the stepwise inclusion method described by Imbens and Rubin[9] or forced into the model if deemed clinically relevant (Supplementary Table, online only). The comparability of the two initial cohorts was confirmed by qualitatively examining the overlapping distributions of propensity scores (common support; Supplementary Fig 1, online only). An inverse probability of treatment weight based on the propensity score was then calculated for each subject and applied to both cohorts; stabilized weights were used to correct for outliers.[10] Adequate balance between the weighted EVAR and open repair groups was confirmed using standardized differences.[9] The final adjusted analyses were conducted using these weighted cohorts. A supplemental analysis extended this study to those up to the age of 70 years.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected Vascular Quality Initiative data
- **Take Home Message:** There were 2641 elective abdominal aortic aneurysm repairs performed in patients ≤65 years of age, with a low in-hospital mortality after both open and endovascular repair (0.9% vs 0.2%; $P < .001$). Patients undergoing endovascular aneurysm repair had no 1-year survival benefit over patients undergoing open repair (97.4% vs 97.3%; $P = .9$).
- **Recommendation:** Data of large prospective trials may not apply to patients ≤65 years of age, and long-term durability data are needed to guide decision-making for abdominal aortic aneurysm repair in this population.

Statistical analysis. Two-sample *t*-test, χ^2 test, Fisher exact test, Wilcoxon rank sum test, and Kruskal-Wallis test were used for unadjusted comparisons between the two cohorts where appropriate. Normality was assessed qualitatively using histogram plots for continuous variables. Analysis of in-hospital and 1-year binary outcomes was performed using logistic regression; analysis of reintervention rates over time was done using negative binomial regression to account for multiple reinterventions per patient. All analyses were performed using Stata 13.1 (StataCorp LP, College Station, Tex) and R 3.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Of 22,268 patients undergoing AAA repair from 2003 to 2014, we identified 2641 (11.9%) patients meeting the inclusion criteria. We excluded 17,538 (78.8%) because of age criteria; subsequently, 416 were excluded for unfit for open repair status, 576 for suprarenal clamping, 958 for urgent or ruptured status, and 139 for concomitant renal artery bypass. EVAR was performed in the majority of patients (73%; n = 1928) compared with open repair