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Outcomes for symptomatic abdominal aortic aneurysms in the American College of Surgeons National Surgical Quality Improvement Program

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Background: **Historically, symptomatic abdominal aortic aneurysms (AAAs) were found to have intermediate mortality compared with asymptomatic and ruptured AAAs; but with wider use of endovascular aneurysm repair (EVAR), a more recent study suggested that mortality of symptomatic aneurysms was similar to that of asymptomatic AAAs. These prior studies were limited by small numbers. The purpose of this study was to evaluate the mortality and morbidity associated with symptomatic AAA repair in a large contemporary population.**

Methods: **All patients undergoing infrarenal AAA repair were identified in the 2011 to 2013 American College of Surgeons National Surgical Quality Improvement Program, vascular surgery targeted module. We excluded acute conversions to open repair and those for whom the surgical indication was embolization, dissection, thrombosis, or not documented. We compared 30-day mortality and major adverse events for asymptomatic, symptomatic, and ruptured AAA repair, stratified by EVAR and open repair, with univariate analysis and multivariable logistic regression.**

Results: **There were 5502 infrarenal AAAs identified, 4495 asymptomatic aneurysms (830 open repair, 3665 [82%] EVAR), 455 symptomatic aneurysms (143 open repair, 312 [69%] EVAR), and 552 ruptured aneurysms (263 open repair, 289 [52%] EVAR). Aneurysm diameter was similar between asymptomatic and symptomatic AAAs when stratified by procedure type, but it was larger for ruptured aneurysms (EVAR: symptomatic 5.8 ± 1.6 cm vs ruptured 7.5 ± 2.0 cm [$P < .001$]; open repair: symptomatic 6.4 ± 1.9 cm vs ruptured 8.0 ± 1.9 cm [$P < .001$]). The proportion of women was similar in symptomatic and ruptured AAAs (27% vs 23%, respectively; $P = .14$) but lower in asymptomatic AAAs (20%; $P < .001$). Symptomatic AAAs had intermediate 30-day mortality compared with asymptomatic and ruptured aneurysms after both EVAR (1.4% asymptomatic vs 3.8% symptomatic [$P = .001$]; symptomatic vs 22% ruptured [$P < .001$]) and open repair (4.3% asymptomatic vs 7.7% symptomatic [$P = .08$]; symptomatic vs 34% ruptured [$P < .001$]). After adjustment for age, gender, repair type, dialysis dependence, and history of severe chronic obstructive pulmonary disease, patients undergoing repair of symptomatic AAAs were twice as likely to die within 30 days compared with those with asymptomatic aneurysms (odds ratio [OR], 2.1; 95% confidence interval [CI], 1.3-3.5). When stratified by repair type, the effect size and direction of the ORs were similar (EVAR: OR, 2.4 [95% CI, 1.2-4.7]; open repair: OR, 1.8 [95% CI, 0.86-3.9]) although not significant for open repair. Patients with ruptured aneurysms had a sevenfold increased risk of 30-day mortality compared with symptomatic patients (OR, 6.5; 95% CI, 4.1-10.6).**

Conclusions: **Patients with symptomatic AAAs had a twofold increased risk of perioperative mortality compared with patients with asymptomatic aneurysms undergoing repair. Furthermore, patients with ruptured aneurysms have a sevenfold increased risk of mortality compared with patients with symptomatic aneurysms. (J Vasc Surg 2016;64:297-305.)**

The 30-day mortality rate for abdominal aortic aneurysm (AAA) repair can range from approximately 1% to >70%, depending on whether the aneurysm is intact, symptomatic, or ruptured.[1-6] In prior studies, 3% to 15% of treated aneurysms have been described as symptomatic.[7-10] Symptomatic AAAs present with symptoms of abdominal or back pain, often associated with tenderness to palpation of the aneurysm itself, and are thought to represent an intermediate-risk group between elective and ruptured aneurysms.

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Historically, many single-institution studies showed that patients with symptomatic AAAs had higher rates of mortality and major adverse events compared with asymptomatic AAA repairs.[7,10-14] However, most of these studies predated the wide use of endovascular aneurysm repair (EVAR) and had small numbers of symptomatic AAAs. De Martino et al, using a contemporary clinical registry, the Vascular Study Group of New England (VSGNE), from 2003 to 2009, showed that there was no difference in in-hospital mortality between symptomatic and elective infrarenal AAA repairs when stratified by procedure type.[8] This study had the largest cohort of symptomatic AAAs treated with EVAR at the time. Before this study, Cambria et al reported that deferral of operation to medically optimize the patient and to ensure that appropriate staff are available, instead of immediate repair within the first 4 hours, improved outcomes for the symptomatic AAAs.[7] This led to an increased focus on preoperative management of the symptomatic patient and was thought to contribute to the lack of difference in perioperative mortality between elective and symptomatic patients in De Martino's study. However, many still believe that symptomatic AAAs continue to have an intermediate operative mortality risk in the short term, but there have been no studies with a current-practice distribution of EVAR and open repair and an adequate number of symptomatic AAA patients to address this ongoing question.

The purpose of this study was to analyze the differences in mortality and morbidity of patients between symptomatic AAAs and both asymptomatic and ruptured aneurysms in a contemporary population in which EVAR was the preferred treatment modality for elective repair.

METHODS

Data set. Using the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) vascular surgery targeted module from 2011 to 2013, we identified all patients undergoing endovascular (EVAR) and open AAA repair. The NSQIP vascular surgery targeted module is an extension of the original NSQIP with 72 participating hospitals in the AAA module as of 2013. It is a multi-institutional collaboration that continues to collect all the preoperative, intraoperative, and 30-day outcomes that were contained in the original NSQIP as well as further clinical detail selected by vascular surgeons in an effort to better risk adjust and determine best practices. Trained clinical nurse reviewers complete all data collection, and each hospital has a surgeon champion, available to answer any questions related to data entry for cases submitted. Additional information on the NSQIP is available at www.facs.org/quality-programs/acs-nsqip.

Patients and cohorts. All 6703 patients undergoing AAA repair in the targeted NSQIP were identified. For direct comparison to prior studies, the primary analysis of this paper focused on repair of infrarenal aneurysms, as identified by proximal aneurysm extent. Juxtarenal aneurysms were included in the analysis with adjustment in multivariable analysis. A subset of patients who were documented to have infrarenal aneurysm extent yet had a suprarenal clamp position were reclassified as juxtarenal. All those with a proximal aneurysm extent listed as pararenal, suprarenal, or type IV thoracoabdominal were excluded from the analysis. Patients with no documented proximal aneurysm extent or operative indication were excluded (n = 439 and n = 81, respectively). Patients with an operative indication of dissection, thrombosis, or embolization or those undergoing conversion from EVAR to open repair (n = 33) were also excluded.

Patients with symptomatic AAAs were defined as those without evidence of rupture but presenting with abdominal or back pain or symptoms from local compression by the aneurysm causing early satiety, hydronephrosis, or deep venous thrombosis. Ruptured aneurysms were divided into two groups based on hemodynamic status: hypotensive (defined as systolic blood pressure <90 mm Hg or drop in systolic blood pressure of >40 mm Hg from baseline or need for pressors preoperatively) and nonhypotensive. The asymptomatic nonruptured group consisted of those with a surgical indication for repair listed as diameter, prior open repair with unsatisfactory result, or prior endovascular repair with unsatisfactory result. The last two indications were accepted because it was thought likely that the symptomatic and rupture groups contained some of these patients as well, as only one indication can be entered per patient.

All variable definitions captured by the NSQIP can be found at www.facs.org/quality-programs/acs-nsqip. New or aggregate variables used in this analysis included obesity, defined as a body mass index >30, and a binary variable for diabetes mellitus, defined as both insulin-dependent and non-insulin-dependent diabetes. For EVAR, percutaneous access included attempted but failed percutaneous access attempts. We consolidated the main body devices analyzed and created an "other" group that included Cook Medical (Bloomington, Ind) Zenith Fenestrated (1.9%) and Zenith Renu (1.4%), Lombard Medical (Irvine, Calif) Aorfix (<0.1%), Medtronic (Santa Rosa, Calif) AneuRx (0.2%) and Talent (0.6%), TriVascular (Santa Rosa, Calif) Ovation (0.9%), and other (4.1%); 10% of patients were missing data on lower extremity revascularization, but these patients were considered as not having revascularization in our analysis. Time from admission to operation was recorded in days, with day 0 representing operation on day of admission. We identified patients undergoing surgery after the day of admission to highlight the number of symptomatic patients who have a delay in their repair because this has been shown to affect outcomes in prior literature.[7] Operative details and outcomes were presented for EVAR and open repair separately.

All outcomes were within 30 days of the index operation. A major adverse event was defined as a myocardial infarction (diagnosed as new Q waves on electrocardiography and documentation stating diagnosis of myocardial infarction), intraoperative cardiac arrest, pneumonia, prolonged intubation (defined as >48 hours), worsening renal function (defined as a rise in creatinine concentration