

From the Society for Vascular Surgery

Female sex independently predicts mortality after thoracic endovascular aortic repair for intact descending thoracic aortic aneurysms

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ABSTRACT

Objective: Whereas sex differences in the pathogenesis, presentation, and outcomes of repair for abdominal aortic aneurysms are well studied, less is known about sex differences after thoracic endovascular aortic repair (TEVAR). The goal of this study was to evaluate the association between sex and morbidity and mortality after TEVAR.

Methods: A retrospective review of all TEVARs in the Society for Vascular Surgery Vascular Quality Initiative (VQI) registry from 2011 to 2015 was conducted, excluding those with dissection, trauma, and rupture. Statistical analysis was performed using the Fisher exact test and the Mann-Whitney *U* test for categorical and continuous variables. Multivariable logistic regression and Cox hazards modeling were used to account for differences in demographics, comorbidities, and aneurysm characteristics in 30-day mortality and long-term survival.

Results: We identified 2574 patients (40% women) who underwent TEVAR. Women were older, were less likely to be white, and had smaller aortic diameters but larger aortic size indices (aortic diameter/body surface area). Women also had more chronic obstructive pulmonary disease but less coronary artery disease and fewer coronary interventions. Women were more likely to be symptomatic at presentation and subsequently to have a nonelective procedure. Women had higher estimated blood loss >500 mL (20% vs 17%; $P = .04$), were more likely to be transfused (29% vs 21%; $P < .001$), and more frequently underwent iliac access procedures (4.3% vs 2.1%; $P < .01$). Operative time and left subclavian intervention were similar. Postoperatively, women had increased median hospital (5 vs 4 days; $P < .001$) and intensive care unit (2.5 vs 2 days; $P < .001$) lengths of stay and were less likely to be discharged home (75% vs 86%; $P < .001$). Mortality was higher for women at 30 days (5.4% vs 3.3%; $P < .01$) and 1 year (9.8% vs 6.3%; $P < .01$). After adjusting for age, aortic size index, symptoms, and comorbidities, female sex remained independently predictive of 30-day mortality (odds ratio, 1.5; 95% confidence interval, 1.1-2.1, $P < .01$) and long-term mortality (hazard ratio, 1.3; 95% confidence interval, 1.03-1.6; $P = .02$).

Conclusions: Even after adjusting for differences in age and comorbidities, female patients have higher perioperative mortality and lower long-term survival after TEVAR. These findings, along with the rupture risk by sex, should be considered by clinicians in determining the timing of intervention. (J Vasc Surg 2017;■:1-7.)

Sex differences in outcomes after vascular surgery exist and are well described for abdominal aortic aneurysms, with female patients having higher rates of rupture and worse outcomes after both open and endovascular repair.¹⁻⁵ However, much less is known about sex differences in outcomes after repair of descending thoracic aortic aneurysms.^{6,7} Although several prospective trials

have suggested sex differences, especially in vascular complications, after thoracic endovascular aortic repair (TEVAR), these have been secondary observations and not part of the primary study aim.⁸⁻¹⁰ Institutional studies assessing sex differences after TEVAR have suggested no difference in mortality, although these were limited by small sample sizes.^{11,12}

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One recent, large retrospective study of TEVAR using National Surgical Quality Improvement Program data showed female sex to be associated with increased 30-day mortality.¹³ However, the association lost statistical significance after adjusting for intraoperative variables, including operative time and use of iliac artery exposure, suggesting that the mortality difference may be, in part, explained by varying aortoiliac and femoral arterial disease burden between sexes. Further investigation with aneurysm- and vascular-specific data is needed to better elucidate this relationship. Therefore, the goal of this study was to evaluate the relationship between sex and outcomes after TEVAR in a contemporary series, with focus on 30-day and long-term mortality.

METHODS

The Beth Israel Deaconess Medical Center Institutional Review Board approved this study and waived informed consent because of the use of deidentified data.

Population. This is a retrospective cohort study using the Society for Vascular Surgery Vascular Quality Initiative (VQI), which is a national clinical registry established as a collaboration between regional quality groups in an effort to improve patient care through the prospective collection of clinical data. At the time of this analysis, the VQI included 16 regions and >300 participating hospitals. Within participating hospitals, complete capture of all included procedures is expected, with regular performance reviews to ensure compliance. More information about the VQI can be found at www.vascularqualityinitiative.org. We identified all patients undergoing TEVAR for descending thoracic aortic aneurysm between 2011 and 2015 and excluded those with trauma (n = 262), dissection (n = 873), or rupture (n = 305). As the TEVAR database in the VQI contains TEVAR and complex endovascular aneurysm repair (EVAR) patients, all complex EVAR patients were also excluded (n = 699).

Variables. Demographics, comorbid conditions, operative details, and in-hospital postoperative outcomes were identified for all patients. Aortic diameter was defined by the VQI as the maximum total aortic diameter within the diseased segment being treated. Body mass index (BMI) and body surface area (BSA) were calculated for each patient using height and weight information. We used the standard formula for BMI: $BMI = \text{weight (kg)} / \text{height (m}^2\text{)}$; and we used the Dubois and Dubois formula¹⁴ for BSA: $BSA = [\text{weight (kg)}^{0.425} \times \text{height (m)}^{0.725}] \times 0.20247$. Aortic size index was defined as aortic diameter/BSA.^{3,15} Smoking history was defined as current or former smoking. A single preoperative creatinine value was used to estimate the glomerular filtration rate for each patient using the Modification of Diet in Renal Disease study equation,¹⁶

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected multicenter Vascular Quality Initiative (VQI) registry data
- **Take Home Message:** In this VQI study of 2574 patients with elective thoracic endovascular aortic repair (TEVAR), both 30-day and 1-year mortality rates were higher in women than in men, and female sex was an independent predictor of mortality after TEVAR.
- **Recommendation:** These data recommend that female sex be considered an independent predictor of mortality after TEVAR.

and renal insufficiency was considered present for estimated glomerular filtration rate <30 mL/min/1.73 m². Preoperative anemia was defined as hemoglobin <10 g/dL. Preoperative functional status was defined as independent if the patient could perform light work and self-care and was not under assistive care or bed bound. The presence or absence of other comorbidities was recorded in a binary fashion. Symptomatic patients were those presenting with symptoms but without rupture, as defined by the VQI. Intraoperative iliac access procedures included all staged or concomitant iliac angioplasty, stent, bypass, or temporary conduit used to facilitate delivery of the endovascular device, as defined by the VQI. Thirty-day and long-term mortality were deduced using linkage between the VQI and the Social Security Death Index. In-hospital postoperative complications were recorded per the VQI registry and included new stroke, myocardial infarction, pulmonary complication including pneumonia or reintubation, temporary or permanent renal replacement therapy, intestinal ischemia, any postoperative blood transfusion, and spinal cord ischemia. A composite variable for major adverse events was created that includes 30-day death, stroke, temporary or permanent new renal replacement therapy, and spinal cord ischemia. Of note, as there were missing data for the spinal cord ischemia variables, patients with missing data were treated as if they did not have the complication for the composite end point.

Statistical analysis. Categorical variables were presented as percentages. Continuous, non-normally distributed variables were presented as median (interquartile range). Differences between cohorts were assessed using the Fisher exact test for categorical variables and the Mann-Whitney *U* test for continuous variables, where appropriate. Logistic and Cox hazards regression modeling were used to assess the independent association between female sex and 30-day and long-term mortality, respectively. Purposeful selection was used to identify covariates for inclusion in our multivariable models. This method includes variables

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