Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Society of Asian Academic Surgeons

Sex-dependent outcomes following elective endovascular aortic repair

Connie Truong, BS,[a] Nathan W. Kugler, MD,[a] Peter J. Rossi, MD,[a] Parag J. Patel, MD,[b] Robert A. Hieb, MD,[b] Kellie R. Brown, MD,[a] Brian D. Lewis, MD,[a] Gary Seabrook, MD,[a] and Cheong J. Lee, MD[a,*]

[a] Division of Vascular Surgery, Department of Surgery, Medical College of Wisconsin, Milwaukee, Wisconsin
[b] Division of Interventional Radiology, Department of Radiology, Medical College of Wisconsin, Milwaukee, Wisconsin

ARTICLE INFO

Article history:
Received 29 December 2017
Received in revised form
1 March 2018
Accepted 13 March 2018
Available online 30 April 2018

Keywords:
Abdominal Aortic Aneurysm
Endovascular Aneurysm Repair
EVAR
Sex Differences
AAA

ABSTRACT

Background: Evidence has shown that women derive less benefit from endovascular aortic repair (EVAR) in large part due to more challenging aortoiliac anatomy. This study sought to examine whether sex-dependent outcomes exist following elective EVAR cases.

Methods: An institutional retrospective review was performed on patients who underwent elective EVAR procedures between 2008 and 2014. Outcome data collected included procedural and hospital morbidity, mortality, and overall EVAR durability based on the incidence of unplanned graft-related secondary interventions (SIs) (e.g., open conversion, proximal or distal extensions, and coil embolizations).

Results: One hundred eighty-one patients (150 men, 31 women) met the study inclusion criteria. Median follow-up was 40.3 mo. Women had more challenging anatomy compared to men including smaller overall iliac diameters (6.8 mm *versus* 8.0 mm, $P < 0.001$) and more severe iliac angulation (77% moderate to severe *versus* 44%, $P < 0.001$). Women had increased risk of postoperative complications compared to men (41.9% *versus* 11.3%, $P = 0.003$). There was no perioperative mortality in our series of elective EVAR cases. Median 5-y survival following EVAR was 64.4% for men and 76.3% for women ($P = 0.599$). Late SI rates following EVAR was 10.5% with 16 (10.7%) men and 3 (9.7%) women needing interventions ($P = 0.870$). Overall durability of EVAR extrapolated as time to SIs was 91% at 2 y and 85% at 5 y. Factors predisposing SIs were iliac tortuosity ($P = 0.046$), aortic neck angle ($P = 0.022$), and endoleak at the follow-up ($P = 0.030$).

Conclusions: In this study, immediate outcomes following EVAR were different between men and women, with women having increased rates of postoperative complications. Mortality and overall long-term durability of EVAR, however, were the same between

Presented at the Annual Society of Asian Academic Surgeons Meeting, Palo Alto, CA, September 23 and 24, 2016.
Presented at the 44th Annual Symposium of the Society for Clinical Vascular Surgery, Las Vegas, NV, March 12-16, 2016.

* *Corresponding author*. Division of Vascular Surgery, Medical College of Wisconsin, 9200 W Wisconsin Avenue, Milwaukee, WI 53213. Tel.: +1 414 805 9160; fax: +1 414 805 9170.
E-mail address: cjlee@mcw.edu (C.J. Lee).

https://doi.org/10.1016/j.jss.2018.03.015

sexes despite anatomical differences. EVAR durability was significantly dependent on the severity of iliac tortuosity, aortic neck angulation, and presence of endoleak at the follow-up.

Introduction

Manifestation of abdominal aortic aneurysm (AAA) in women is rare, yet the pathophysiologic differences are significant compared to men. It has been shown that women have a faster rate of aneurysm growth and a higher risk of rupture at lower size thresholds.[1] Since its conception, endovascular aortic repair (EVAR) has led to significant improvements in AAA treatment outcomes.[2-6] There is mounting evidence, however, that the benefit of EVAR may be biased toward men. Numerous reports have suggested women have higher perioperative mortality rates, complication rates, and increased need for secondary interventions (SIs) largely due to inherent differences in comparative vessel anatomy.[7-15] Hostile aortoiliac anatomy, such as greater aortic neck angulation and smaller and angulated access vessels, are more often encountered in women.[6,16-19] Earlier iterations of stent grafts were relatively unforgiving due to large device profile, lack of hydrophilic delivery platform, and general rigidity of its design. As such, many women with difficult access anatomy were not candidates for EVAR or were at risk for device-related complications.[20,21] Current endograft technology addresses some of the challenging anatomic factors found in women with AAA.[3,4,6] These improvements include development of lower profile and hydrophilic delivery systems in addition to the design of more flexible and conformable endografts.[4,6,20]

With advancements in endograft devices, anatomy-dependent and consequently sex-based adverse outcomes after EVAR should not persist, but there is still paucity of evidence examining this suspected trend. Comparable mortality and outcomes are being demonstrated between the sexes in other vascular interventions, but a consensus on whether women derive equal benefit from EVAR remains to be elucidated.[7-9,11,12] In this report, immediate- and long-term outcomes with contemporary EVAR experience is examined with specific attention to sex-derived differences.

Methods

An Institutional Review Board-approved retrospective review of patients from a prospectively collected database who underwent elective EVAR for AAA was conducted from 2008 to 2014 at the Froedtert Hospital in Milwaukee, Wisconsin. Patient informed consent was not required for the study. Emergent cases (ruptured or symptomatic AAA), non-AAA cases, or cases without documented follow-up were excluded. Any patients with custom- or physician-modified grafts were excluded. Only patients with an infrarenal AAA were included; all patients with juxtarenal or thoracoabdominal anatomy were excluded. All EVAR procedures were performed transfemorally with either elective open femoral artery exposure or percutaneously by a team consisting of one attending vascular surgeon and one attending interventional radiologist. All procedures were performed under general anesthesia. Before 2012, EVAR procedures were performed in the interventional radiology suite while a hybrid operating room was being built. EVAR procedures were subsequently transitioned to the dedicated hybrid operating room in 2012. Patients were under a strict follow-up protocol that required contrast computed tomography scan at 1, 6, and 12 mo after surgery, and then annually thereafter.

Demographics, comorbidities, perioperative, and postoperative data were reviewed. Coronary artery disease (CAD) was defined as any prior history of myocardial infarction (MI), having a prior history of coronary intervention, or documented CAD requiring medical management. Prediabetes in this study was defined by having any prior history of impaired fasting glucose levels not requiring pharmacologic treatment. Renal disease was defined by documented glomerular filtration rate <60 mL/min/1.73 m^2. Postoperative cardiac events were defined as any MI or new cardiac arrhythmias. MI was defined as any electrocardiography changes or clinical evidence of MI in conjunction with any abnormality of cardiac biomarker consistent with infarction (creatine kinase MB or troponin). Postoperative renal failure was defined as an increase >0.5 mg/dL (44.2 μmol/L) above the preoperative value.

Computed tomography scans were used to assess procedural anatomy, which was independently verified by one attending vascular surgeon and two attending interventional radiologists. Degree of aortic neck angulation was defined as mild (0°-30° from centerline of flow), moderate (30°-60° from centerline of flow), and severe (>60° from centerline of flow). Iliac artery tortuosity was assessed using the number of iliac angulations that was greater than 90° from centerline pathway of endograft delivery and graded mild, moderate, and severe (Supplemental Fig. I). Centerline assessments were made using TeraRecon software (Foster City, CA). Follow-up data, including any aneurysm-related SIs and aneurysm-related mortality were collected. In addition, imaging data including endoleaks, aneurysm sac diameters, evidence of endograft migration, and device component separation were collected. Endograft implants consisted of commercially available grafts, aortic cuff/limb extensions, and iliac extensions. Unplanned procedures during initial EVAR were defined as any unanticipated access and aortic graft-related interventions including iliac stent placement, renal stent placement, open revascularization, and conversion to open surgery. Overall EVAR durability was based on the incidence of unplanned graft-related SIs in the follow-up (open conversion, proximal or distal extensions, and coil embolization).

Categorical variables were presented as counts and percentages. Fisher's exact test was used for categorical variables and the Mann Whitney *U*-test was used for continuous variables to compare demographic, perioperative, and postoperative outcomes. Survival and freedom from SIs following