Gender Differences in Aortic Neck Morphology in Patients with Abdominal Aortic Aneurysms Undergoing Elective Endovascular Aneurysm Repair

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Background: Previous studies have demonstrated that women tend to have adverse aortic neck morphology leading to exclusion of some women from undergoing endovascular aneurysm repair (EVAR). The objective of this study is to investigate differences in aortic neck morphology in men versus women, changes in the neck morphology and sac behavior after EVAR, and investigate how these features may influence outcomes.
Methods: We conducted a retrospective review of elective EVARs (2004–2013). We excluded patients who underwent elective EVAR with no postoperative imaging available and those patients with fenestrated repairs. Using TeraRecon and volumetric analysis, several features were investigated. These included percent thrombus, shape, length, angulation of the neck, and changes in neck and abdominal aortic aneurysm diameter.
Results: A total of 146 patients were found to meet inclusion criteria (115 men and 31 women) with similar baseline characteristics. Neck angulation was greater in women (23.9° vs. 13.5°; $P < 0.028$). The percent thrombus in women was higher than men (35.4% vs. 31%; $P < 0.02$). Abdominal aneurysm's were smaller in women at 1 year (4.2 cm vs. 5.1 cm; $P < 0.002$), and secondary interventions were higher in men (11.3% vs. 0%; $P < 0.05$). Other features such as neck shape, changes in neck diameter, neck length, and percent oversizing of graft where not statistically different between genders.
Conclusions: Gender differences in neck characteristics and changes in neck morphology do not appear to adversely affect EVAR outcomes. Longer follow-up is necessary to further assess whether these findings are clinically durable.

INTRODUCTION

Abdominal aortic aneurysms (AAAs) are significantly more common in men than women by a factor of 4:1.[1] However, women have a higher mortality and morbidity associated with endovascular aneurysm repair (EVAR). The 30-day mortality rate for women is 3 times greater than for men after EVAR. Women have also been shown to be more prone to access-related ischemia, iliac and aortic neck rupture, colonic ischemia, and type 1 endoleak.[2,3] The reasons for the higher morbidity and mortality are not entirely clear but may related to smaller access vessels and more hostile anatomic features of the aorta. In addition, women are more often found to have prohibitive aortoiliac anatomy which makes them poor candidates for EVAR based on current food and drug administration-approved devices instruction for use.[2,3]

The successful treatment of AAA has been classically defined as shrinkage of the aneurysm sac with the absence of endoleak.[4–9] The ability to predict sac

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behavior remains elusive and an important area of investigation. There have been reported cases of aneurysm shrinkage despite the presence of endoleak and other cases of expansion of the sac in the absence of endoleak.[10] Although most physicians may favor traditional 2-dimensional imaging of the aneurysm for purposes of obtaining preoperative measurements and postoperative surveillance, this technique is limited and may not always be accurate. Volumetric analysis and 3-dimensional reconstruction of the aneurysm sac have emerged as potentially a more accurate and efficient means for defining morphologic features of the aorta during preoperative planning as well as for postoperative surveillance.[11–14] Volumetrics may be especially useful in providing more precise measurements of aortic neck thrombus burden, when compared with more subjective measurements on 2-dimensional imaging. Despite its potential, the utility of 3-dimensional imaging and volumetric analysis for assessing aortic neck morphology has not been well established. Indeed, aortic neck thrombus is most often measured on axial computed tomography (CT) imaging as a percentage thickness.

The purpose of this study is to identify gender specific differences in aortic neck morphology and thrombus burden of the aortic neck using volumetric analysis, and to attempt to elucidate morphologic features that may predict outcomes by EVAR.

METHODS

Our study is a retrospective single institution review conducted at New York University Langone Medical Center between 2004 and 2013. Most of our elective EVARs who met inclusion criteria occurring from 2007 to 2013 (83%). Inclusion criteria consisted of patients who underwent elective infrarenal EVAR with preoperative and postoperative thin cut (1–4 mm) contrast CT images available for review. Patients were excluded if they underwent emergent EVAR for rupture, fenestrated repair, or endovascular repair for other etiologies such as isolated iliac aneurysms.

CT Image Acquisition

CT angiography of the aorta and pelvic arteries was performed using a 40-, 64-, or 128-multidetector computed tomography scanner (Somatom Sensation or Definition, Siemens Healthcare). Definition models were operated in a single-source mode. Scans were obtained using a reference 120 kVp and approximately 150–240 mAs and extended from the diaphragm to the pubic symphysis. Imaging was obtained after injection of a 1.5 mL/kg dose of nonionic intravenous contrast material (iopromide 350 mg I/mL, Ultravist, Bayer Healthcare) at a rate of 3–5 mL/sec via power injector (Envision; Medrad, Pittsburgh, PA) through a 20-ga needle inserted into an antecubital vein. Images were obtained during peak aortic enhancement using a bolus tracking method. A total of 500 mL of water was used for oral contrast. Images were reconstructed in the axial plane at 1-, 2-, 3-, or 4-mm slice thickness with 1-, 2-, 3-, or 4-mm slice intervals, and in the coronal plane at a 3-mm slice thickness with 3-mm slice intervals. Three-dimensional volume-rendered images and maximum intensity projection images were created on an independent workstation (TeraRecon Aquarius iNtuition, San Mateo, CA) for CT angiographic display.

Quantitative Assessment

Infrarenal neck angle, neck length, neck dilatation, and percent oversize of graft were calculated. Neck dilatation was determined to be $>$ 5 mm increase in diameter on postoperative CT scan compared with preoperative CT. All measurements were obtained in a plane perpendicular in reference to the center line. The minimum wall-to-wall diameter of the aneurysm neck was measured at the level of the renal arteries and 5, 10, and 15 mm below the level of the renal arteries.

The aneurysm neck thrombus volume was calculated at 5, 10, and 15 mm below the renal arteries by calculating the difference of the inner wall volume (lumen) from the outer wall volume (entire aortic volume). The percent thrombus was then calculated by dividing the volume thrombus and/or outer wall volume.

The shape of the aneurysm neck was recorded as either funnel, conical, or cylindrical (tubular), and represented a >10% change in diameter (±) from proximal to distal.

All radiographic findings were evaluated by a radiologist and then independently verified by 2 surgeons.

STATISTICS

Descriptive and comparative analyses were performed using chi-squared test for categorical variables and paired *t*-test for continuous variables. All reported P values are 2-sided and $P < 0.05$ was considered statistically significant. Analyses were performed in SPSS version 19.0 (IBM SPSS Statistics, 2010).