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Endovascular Treatment of Ruptured Abdominal Aortic Aneurysms with Hostile Aortic Neck Anatomy

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WHAT THIS PAPER ADDS

Patients with a ruptured AAA are often excluded from EVAR based on aortic morphology. This paper evaluates technical and clinical outcomes of emergency EVAR in patients with hostile infrarenal aortic neck anatomy and reports excellent results, suggesting that emergency EVAR in ruptured AAA with hostile aortic neck anatomy is technically feasible and safe in experienced hands.

Objective: To compare the mid-term results of endovascular aortic aneurysm repair (EVAR) for ruptured abdominal aortic aneurysms (RAAAs) in patients with favourable aortic neck anatomy (FNA) and hostile aortic neck anatomy (HNA).

Methods: Patients treated for a RAAA in a high volume endovascular centre in the Netherlands between February 2009 and January 2014 were identified retrospectively and divided into two groups based on aortic neck anatomy, FNA and HNA. HNA was defined as RAAA with a proximal neck of $<$10 mm, or a proximal neck of 10–15 mm with a suprarenal angulation (α) $>45^\circ$ and/or an infrarenal angulation (β) $>60^\circ$, or a proximal neck of $>$15 mm combined with $\alpha > 60^\circ$ and/or $\beta > 75^\circ$. Patient demographics, procedure details, 30 day and 1 year outcomes were recorded.

Results: Of 39 included patients, 17 (44%) had HNA. Technical success was 100% for FNA and 88% for HNA ($p = .184$). There were no type IA endoleaks on completion angiography in either group; however, more adjunctive procedures were necessary for intra-operative type IA endoleaks in the HNA group (24% vs. 0%, $p = .029$). Thirty day mortality rates were comparable, FNA 14% vs. HNA 12% ($p = 1.000$). There were no statistically significant differences at 1 year follow up in type I endoleaks, secondary endovascular procedures, or all cause mortality.

Conclusion: Emergency EVAR provides excellent results for treatment of RAAA patients with both FNA and HNA. EVAR in RAAAs with HNA is technically feasible and safe in experienced endovascular centres.

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INTRODUCTION

A ruptured abdominal aortic aneurysm (RAAA) is fatal without emergency surgical intervention. The first report of a successful endovascular treatment of RAAA was published in 1994.[1] With doctors becoming more experienced in endovascular techniques, and also the improved availability of off the shelf endografts, an increasing number of RAAA patients undergo endovascular treatment. Endovascular aneurysm repair (EVAR) might improve short-term survival rates of RAAA patients compared with traditional open surgical repair (OR).[2] The implementation of an EVAR first strategy for RAAAs in experienced centres shows an improved clinical outcome.[3] However, according to the best available data, the IMPROVE trial, the AJAX trial, and a recent meta-analysis, there is no significant difference in short-term survival rates between EVAR and OR.[4–6]

The choice between OR and EVAR is based on operator preference, patient characteristics, and anatomical suitability. Anatomical suitability is defined in the instructions for use (IFU) of each endograft. With the evolution of endografts, the anatomical suitability for EVAR increased from 20% to approximately 46–64% with current devices.[4,5,7] Unfavourable aneurysm anatomy and adverse anatomical characteristics of the aortic neck could be

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predictors of poorer short-term outcomes.[8] However, in experienced endovascular centres, an increasing number of patients with abdominal aortic aneurysms (AAA) are treated outside the IFU. In the authors' experience, this certainly includes RAAAs.

This study aimed to compare the 1 year results of EVAR for RAAA patients with favourable aortic neck anatomy (FNA) and hostile aortic neck anatomy (HNA).

METHODS

Patient selection

Patients with a proven RAAA were identified retrospectively based on the Dutch administrative code for RAAA (406) in the hospital records of a large, tertiary referral centre for cardiovascular disease in the Netherlands. Patients were included for this analysis if the RAAA had been treated by means of EVAR between February 2009 and January 2014. A RAAA was defined as bleeding outside the adventitia of a dilated aortic wall. The diagnosis of a ruptured AAA was based on clinical findings, an ultrasound (US) in the emergency department, followed by a contrast enhanced computed tomography angiography (CTA) to confirm the diagnosis and allow for precise treatment planning. Patients were excluded if there was no evidence of a rupture. Patients who underwent previous EVAR or OR were also excluded.

Patient clinical status, medical history, treatment and follow up data were collected through hospital, emergency department and operation records.

Patient management

All patients were treated by (or under the supervision of) an experienced endovascular surgeon. The type of treatment (OR or EVAR) was left to the discretion of the surgeon, although under an EVAR first strategy. All patients scheduled for endovascular treatment underwent pre-operative CTA to determine baseline aortic and aneurysmal dimensions. Both bifurcated and aorto-uni-iliac (AUI) devices were used, including Endurant (Medtronic Vascular, Santa Rosa, CA, USA) and Excluder (W.L. Gore and Associates, Flagstaff, AZ, USA). All endografts were implanted through the common femoral artery via a transverse surgical cutdown.

If the prognosis because of comorbidity was exceedingly poor or if treatment options were limited, patients were palliated.

Standard follow up of treated RAAA patients was performed at 1 month with a CTA scan, and yearly thereafter with CTA or duplex ultrasound.

Anatomical evaluation

Two trained researchers blinded for treatment outcome, reviewed all available pre-operative CTAs independently. Measurements were made using dedicated three dimensional (3D) sizing software (3mensio, 3mensio Vascular, Bilthoven, The Netherlands). The central lumen line (CLL) was generated manually. Measurements were taken perpendicular to the CLL, and suprarenal and infrarenal angulations were determined according to the method described by Van Keulen et al.[9] In case of a discrepancy of more than 2 mm neck length or 5° angulation, consensus was obtained by consultation with one of the endovascular surgeons. A common iliac artery (CIA) with a diameter $\geq$17 mm in males or $\geq$15 mm in females was considered aneurysmal.[10]

Definitions and outcomes

The study cohort of patients was divided into two groups based on infrarenal aortic neck anatomy. FNA was defined as a proximal neck of $\geq$15 mm combined with a suprarenal angulation (α) $\leq$60° and an infrarenal angulation (β) $\leq$75° or defined as a proximal neck of $\geq$10 mm combined with α $\leq$45° and β $\leq$60°. HNA was defined as RAAAs with a proximal neck of $<$10 mm, or a proximal neck of 10—15 mm with α $>$45° and/or β $>$60°, or a proximal neck of $>$15 mm combined with α $>$60° and/or β $>$75°. The limits correspond with the instructions for use (IFU) for the Endurant stent graft.

Technical success was defined as successful delivery and deployment of the endograft, without unintentional coverage of renal or visceral arteries, followed by successful removal of the delivery system, and the absence of either a type I or III endoleak. Completion angiography was performed to document any possible endoleaks and other endograft related complications. The duration of procedure was defined as the time between arterial cutdown and closure. Thirty day and 1 year outcomes included endograft related complications, mortality rates, and need for secondary interventions. Significant migration was defined as a displacement of the endograft of $\geq$10 mm. There was no loss to follow up at 1 year.

Statistical analysis

Statistical analyses were performed using SPSS version 21 for MAC (IBM Corporation, Armonk, NY, USA). Categorical variables are presented as frequencies with percentages. The χ^2 or Fisher's exact test were used for categorical variables depending on sample size. Continuous variables are presented as mean $\pm$ standard deviation (SD) or as median and interquartile range (IQR) in case of skewed data. Mean differences were assessed using independent group *t* tests and median differences were assessed using Mann—Whitney *U* tests. A *p* value $<$.05 was considered statistically significant. A per protocol analysis was performed for the technical endograft related observations. All other variables were evaluated on an intention to treat basis. Missing values were excluded for analysis. Follow up data were analysed by Kaplan—Meier life table analysis and the log-rank test.

RESULTS

Patients

69 patients presented with a RAAA at the emergency department between February 2009 and January 2014. Six patients were rejected for surgery based on extensive