CLINICAL STUDY

Outcomes over Time in Patients with Hostile Neck Anatomy Undergoing Endovascular Repair of Abdominal Aortic Aneurysm

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ABSTRACT

Purpose: To assess differences in outcome in an early and later time period in patients with hostile neck anatomy who underwent endovascular aneurysm repair (EVAR).

Materials and Methods: This single-center, institutional review board-approved retrospective study assessed patients who underwent EVAR between 2004 and 2013, divided into 2 time periods: 2004–2008 and 2009–2013. One hundred twenty-five patients had at least 1 hostile neck parameter that met inclusion criteria: 61 of 216 (28%) patients in the early period and 64 of 144 (44%) patients in the late period. Patients in the late group were younger compared to patients in the early group (late group, 74.5 ± 8.8 years vs early group, 77.5 ± 7.5 years; $P = .046$). No significant differences were observed in hostile neck anatomic factors between the early and late periods.

Results: No statistical difference was observed in periprocedural factors or outcome measures, except for abdominal aortic aneurysm (AAA) sac regression in the late period compared to the early period (late period, 73.5% vs early period, 55.7%; $P = .038$). A statistically significant increase was observed in type 1a endoleaks in patients in the late group with suprarenal fixation compared to patients with infrarenal fixation (suprarenal, 27.0% vs infrarenal, 7.9%; $P = .025$) and in the overall time studied (suprarenal, 20.3% vs infrarenal, 7.6%; $P = .045$).

Conclusions: Except for AAA sac regression, no changes were observed in periprocedural factors and outcome measures over time in patients with hostile neck who underwent EVAR.

ABBREVIATIONS

AAA = abdominal aortic aneurysm, EVAR = endovascular aneurysm repair, FEVAR = fenestrated endovascular aneurysm repair, IFU = instructions for use

The quality of the proximal aortic neck is probably the single most important factor in determining outcomes in endovascular aneurysm repair (EVAR). It is directly related to seal and fixation of an endograft and therefore directly affects both type 1a endoleaks and graft migration (1).

Instructions for use (IFU) are based on both clinical and benchtop research, with the goal being to optimize outcomes of EVAR (2). However, over the years, boundaries set by these IFU have been pushed to include more patients, and more challenging neck anatomy, with variable success (3–5). Currently, up to 58% of EVARs are performed outside of the IFU (6). In the literature, hostile neck parameters are defined by neck length $\leq$ 10 mm, focal bulge in the neck $>$ 3 mm, $>$ 2-mm reverse taper within 1 cm below the renal arteries, neck thrombus or calcification $\geq$ 50% of the circumference, and angulation $\geq$ 60% within 3 cm below the renal arteries (7).

In the literature, retrospective observational trials have demonstrated that, over time, outcomes have improved in EVAR (8,9). However, trials assessing outcome trends in patients with hostile neck are largely lacking. The purpose of this study was to assess differences in outcome in early and late time periods in patients with hostile neck anatomy, as a potential marker for possible improvement in technique,

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equipment, and/or experience of the operator in challenging circumstances.

MATERIALS AND METHODS

Study Population

This study was developed in accordance with the Declaration of Helsinki and received institutional review board approval. All consecutive patients admitted to a single institution for elective EVAR between January 2004 and December 2013, documented in a database, were evaluated for inclusion. Patients were suitable for inclusion if they had 1 or more parameters of a hostile neck (see Table 1 for parameters: neck length $\leq$ 10 mm, focal bulge in the neck $>$ 3 mm, $>$ 2-mm reverse taper within 1 cm below the renal arteries, neck thrombus or calcification $\geq$ 50% of the circumference, and angulation $\geq$ 60% within 3 cm below the renal arteries). Included patients had at least 12 months follow-up and preprocedural and postprocedural imaging available in the picture archiving and communication system. Hostile neck anatomy was determined by a double independent retrospective review of the preprocedural imaging. Procedures included those done with infrarenal fixation or suprarenal fixation technique. Patients treated with a "chimney"/"snorkel" technique or fenestrated endovascular aneurysm repair (FEVAR) technique were not included in this study. Patients without at least 1 hostile neck parameter and with unavailable, incomplete, or missing case notes, or who underwent imaging and clinical follow-up at another institution, were excluded from the study.

Procedure Details

The choice of EVAR versus open abdominal aortic aneurysm (AAA) repair for each patient with hostile neck anatomy was individualized for each patient but was ultimately made at the discretion of the board-certified interventionalist. There was no single treatment decision algorithm, but the patient's surgical candidacy and the interventionalist's comfort level influenced the decision. Intervention was considered when the maximum AAA diameter was at least 50 mm and/or increase in maximum diameter of at least 5 mm in 6 months was observed. EVAR was performed either percutaneously or with a surgical arteriotomy, as dictated by the patient's anatomy. The device was deployed per the manufacturer's instructions.

By 2004, aortic endografting had been performed at the institution for over 10 years. In the first time period, from 2004 to 2008, there were 5 main operators with 4–10 years of experience; in the period 2009–2013, there were again 5 main operators with 9–15 years of experience. The study was divided into 2 equal time periods, the first from 2004 to 2008 and the second from 2009 to 2013. Devices used from 2004 to 2008 were Endurant (1), Gore Excluder (28), and Zenith (32), and from 2009 to 2013, Endurant (10), Gore (38), Zenith (12), Endologix (3), and Ovation (1). All procedures were technically successful without a death within 30 days.

Table 1. Hostile Neck Parameters

Hostile Neck Parameter
Neck length $\leq$ 10 mm
Focal bulge in the neck $>$ 3 mm
$>$ 2-mm reverse taper within 1 cm below the renal arteries
Neck thrombus or calcification $\geq$ 50% of the circumference
Angulation $\geq$ 60% below within 3 cm the renal arteries

Outcome Measures

Procedural and periprocedural factors were assessed, such as fluoroscopy time, adjunctive procedure, suprarenal versus infrarenal fixation, and length of hospital stay. Outcome measures were stated as type 1a endoleak, AAA sac expansion, and AAA sac regression.

An intraprocedural type 1a endoleak was treated with angioplasty initially and proximal extension with an aortic cuff or use of a Palmaz Stent if angioplasty did not resolve the type 1a endoleak. Computed tomography angiographic follow-up visits were scheduled at 1 month, 6 months, and 12 months after EVAR and yearly thereafter, to monitor AAA sac behavior. Patients with an intraprocedural type 1a endoleak who did not respond to angioplasty only and patients who developed a type 1a endoleak on subsequent imaging were categorized as having a type 1a endoleak. In addition, AAA sac regression was defined as decrease in AAA sac size $>$ 5 mm from the preoperative study or between studies. Similarly, AAA sac expansion was defined as an increase in AAA sac $>$ 5 mm from the preoperative study or between studies.

Patient Characteristics

In total, 415 patients underwent EVAR from 2004 to 2013. Of these, 360 patients (216 in the early period and 144 in the late period) had complete records. Also of these, 125 had at least 1 hostile neck parameter: 61 of 216 patients (28%) in the early time period who underwent EVAR had a hostile neck parameter, and 64 of 144 (44%) patients in the late period who underwent EVAR had a hostile neck parameter. Age ranged from 52 to 94 years, with a mean age of 75.9 years. Ninety-nine patients were men and 26 were women. Follow-up ranged from 12 to 91 months, with a mean follow-up period of 47.3 months. In total, 66 patients underwent infrarenal fixation and 59 underwent suprarenal fixation. Demographic factors were assessed between both groups. No difference was observed in the representation of male sex between both groups. However, a significant difference was observed in age between both groups, with a younger group in the late period (74.5 $\pm$ 8.8 years) compared to the early period (77.5 $\pm$ 7.5 years) ($P = .046$.) (Table 2).

No significant differences were observed in anatomic factors between the early and late periods (Table 3). Short neck anatomy had borderline significance between both groups, with 32 in the late period and 20 in the early period ($P = .051$).

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