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Fenestrated Endovascular Aortic Aneurysm Repair as a First Line Treatment Option to Treat Short Necked, Juxtarenal, and Suprarenal Aneurysms

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WHAT THIS PAPER ADDS

This series reports initial and mid-term outcomes of fenestrated endovascular aneurysm repair (FEVAR) as a first line strategy for short neck, juxtarenal, and suprarenal aortic aneurysms in a large volume center. The study therefore includes both normal surgical risk patients and high surgical risk patients and is a base for comparison with the open surgical literature. FEVAR in a "standard vascular population" is associated with high technical success, low operative mortality and morbidity rates, and excellent mid-term outcomes. The need for re-intervention is low, and most re-interventions can be performed by endovascular techniques.

Objectives: The outcomes of fenestrated endovascular aneurysm repair (FEVAR) as a first line strategy is reported.

Methods: All consecutive patients treated with FEVAR for short neck, juxtarenal, or suprarenal aortic aneurysms under the guidance of the senior author within the period January 2010 to December 2014 were included. Data were collected from a prospectively maintained database. Analyzed outcomes included technical success, defined by successful stent graft implantation with patent stented target vessels and no Type I/III endoleak, operative mortality and morbidity, target vessel patency, endoleak, re-intervention, and death. Survival, target vessel stent patency, and re-intervention during follow up were calculated by Kaplan–Meier analysis.

Results: A total of 281 patients (245 male, mean age 72.1 ± 7.7 years) were treated. The mean aneurysm diameter was 60.2 ± 9.3 mm and median proximal neck length 2 mm (range 0–10 mm). Technical success was 96.8% (272/281). Technical failure included one intra-operative death due to embolization and cardiac arrest, one open conversion due to iliac rupture, and seven target vessel complications. The thirty day mortality was 0.7% (2/281). Mean follow up was 21 ± 15.9 months. Estimated survival at 1 and 3 years was 94.7% ± 1.6% and 84.6% ± 3.0%, respectively. Estimated freedom from re-intervention at 1 and 3 years was 96.1% ± 1.4%, and 90% ± 2.7%. Estimated target vessel stent patency at 1 and 3 years was 98.6% ± 0.5%, and 98.1% ± 0.6%, respectively. Mean aneurysm sac diameter decreased from 60.2 ± 9.3 mm pre-operatively to 53.2 ± 12.8 mm ($p < .001$).

Conclusions: FEVAR as a first line strategy was associated with high technical success and a low operative mortality rate. Efficacy and durability in the mid-term appear very good, with significant regression of aneurysm sac diameter, high target vessel patency, and acceptable rate of re-intervention.

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INTRODUCTION

Fenestrated endovascular aneurysm repair (FEVAR) was first reported in 1999 for the treatment of a juxtarenal aortic aneurysm.[1] The technique was initially developed to treat high risk patients unfit for open surgery and anatomically unsuitable for standard EVAR. Gradually, FEVAR was also offered to patients suitable for open repair. In this institution, FEVAR became the first line treatment for anatomically suitable short neck, juxtarenal, and suprarenal aortic aneurysms from 2010, whereas the main author's experience had already started in 2000 in another institution.

Up to now, most publications on FEVAR have stressed that the patients treated were at high risk for open surgery. In addition, most series included a learning curve. It is therefore difficult to compare published FEVAR series with literature on open repair. Nevertheless, most publications report good results, with acceptable technical success, and safety and durability of the technique in the mid-term.[2–5]

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Recently, sub-optimal outcomes of FEVAR have been published, both in a multicenter trial and in comparison with open surgery.[6,7] In these papers, the authors emphasize the high risk patient selection, both anatomically and with regard to comorbidity, and acknowledge learning curve issues to explain the higher mortality and morbidity.[8]

FEVAR was investigated as a first line treatment option to provide data for later comparison with open surgery. To that end, data from 281 consecutive patients treated over a 5 year period were analyzed.

MATERIALS AND METHODS

All consecutive patients treated with FEVAR for short neck, juxtarenal, or suprarenal aortic aneurysm under the guidance of the senior author within the period January 2010 to December 2014 were included in this study. Patients with Type IV thoraco-abdominal aortic aneurysms treated with fenestrated and branched techniques have been reported elsewhere and were excluded from the present study.[9] Patients with previous failed EVAR or open abdominal aortic surgery were not excluded. Data were collected in a prospectively maintained database. FEVAR as a technique was approved by the institution's ethics committee and all patients provided their informed consent for the procedure.

Aneurysm morphology was assessed by thin cut ($\leq$1.5 mm) spiral computed tomography angiography (CTA) with axial and coronal/sagittal reconstructions. The physical status of all patients was assessed pre-operatively with the American Society of Anesthesiologists (ASA) score. The main indication for FEVAR included a proximal neck too short for standard EVAR, but otherwise suitable anatomy for EVAR in an abdominal aortic aneurysm (AAA) of at least 50 mm in diameter (or an AAA smaller than 50 mm but localized disease, or in conjunction with iliac aneurysm larger than 35 mm).

Anatomical suitability and technique

FEVAR is addressing aneurysms that lack a proximal neck. Other anatomical suitability criteria are similar to standard EVAR. Proximally, fenestrations can be added to move the graft upwards in order to find a long and stable sealing zone above the renal arteries. Femoral and iliac access vessels should be large and healthy enough to not only allow insertion of the delivery system but to also allow for repositioning and reorientation to achieve successful catheterization of the target vessels through the fenestrations. Target vessels must be adequate to achieve insertion and sealing with a covered stent. Unfavorable anatomy of the target vessels includes caliber below 4 mm, extensive arteriosclerotic disease, early bifurcation, and sharp downward take off.

The stent graft deployment technique for fenestrated stent grafts has been previously described in detail.[3,10] In short, the fenestrated tube graft can be opened partially to allow catheterization of the target vessels from the contralateral groin. The target vessels should be secured with guiding sheaths before complete opening of the fenestrated graft. Then the target vessels can be stented. Important technical points include (a) the repositioning of the graft to line up a fenestration with its target vessel, (b) the push-up of the graft against the guiding sheaths before complete deployment to position the fenestrations as high as possible, and (c) stenting of the target vessels from top to bottom to avoid squashing with a balloon used to flare the balloon expandable bridging stent grafts

Stent grafts

Planning of fenestrated stent grafts has been previously described in detail.[10,11] Briefly, stent grafts were customized based on the Cook Zenith system (William A. Cook Australia, Ltd., Brisbane, Australia) fitting fenestrations and scallops for the visceral vessels according to pre-operative CTA measurements. Most commonly, a composite three part system was used consisting of a proximal fenestrated tube, a distal bifurcated component, and a contralateral limb. In some cases of limited working length distally, (e.g. failed previous bifurcated surgical graft or EVAR) a fenestrated cuff only was used. A proximal and distal sealing zone of $\geq$20 mm in length was always planned.

Procedure

The procedures were routinely performed either in an angio suite with a fixed imaging system (Artis Zee, Siemens, Erlangen, Germany), or in a hybrid operating room with a fixed imaging system (Artis Zeego). The operation was always done under general anesthesia. Surgical access was performed via bilateral femoral cut down. Double purse string sutures (Prolene 4-0) fitted with a snugger were used to allow removal of the delivery system of the proximal body completely while stenting the target vessels from the contralateral side. This helped restore blood flow to the ipsilateral limb as early as possible keeping only a stiff guidewire in position, to secure safe introduction of the bifurcated graft later.

Technical success was defined as successful deployment of the planned stent grafts with patent stented target vessels and absence of Type I or III endoleak at the first post-operative CTA.

Post-operative management

Post-operatively, patients were monitored with clinical and laboratory examination including abdominal X-rays in standardized anteroposterior and oblique views as reference before discharge. CTA controls were usually performed at 1 month, 1 year, and thereafter, depending on each patient's characteristics. On suspicion of endoleak or branch vessel malperfusion, additional digital subtraction angiography (DSA) for further evaluation and possible re-intervention was carried out. In cases of straightforward follow up with abdominal X-ray, duplex ultrasonography and renal function, the need for yearly CTA was discussed in group with the purpose to reduce the number of CTAs.

Data analysis

SPSS for Windows (version 20.0; SPSS Inc, Chicago, IL, USA) was used for statistical analysis. Variables are presented as