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Predisposing Factors for Re-interventions with Additional Iliac Stent Grafts After Endovascular Aortic Repair

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WHAT THIS PAPER ADDS

This article reports anatomical and procedural factors associated with iliac limb re-interventions after EVAR. The results suggest that patients with large iliac diameters and short attachment zones may need a greater degree of oversizing than currently recommended in instructions for use and a more vigorous post-operative surveillance.

Background: Endoleaks of type Ib and III are relatively common causes of re-intervention after EVAR. The aim was to determine underlying causes and identify anatomical factors associated with these re-interventions.
Methods: A total of 444 patients with standard bifurcated stent grafts were included in a retrospective observational study. Patients requiring additional iliac stent grafts ($n = 24$) were compared to those who did not ($n = 420$). Pre- and post-operative CT examinations were reviewed in patients with additional iliac stents. Reasons for re-interventions were defined as migration (>5 mm at the distal end or at interconnections), progression of disease (iliac artery diameter exceeding graft diameter), inadequate distal seal length at primary repair, or a combination of these factors.
Results: Twenty-four patients received 31 additional grafts in 30 limbs after a median 46 months (range 2–92 months). Five re-interventions (21%) were due to rupture. Re-intervened limbs had a larger iliac artery diameter 18 mm (25th and 75th percentile 20–25) versus 15 mm (13–18 mm), $p < .001$. The degree of iliac limb oversizing at primary EVAR was lower in re-intervened patients (11% (8–18%) versus 18% (12–26%), $p = .003$). In re-intervened patients, iliac attachment zones were shorter in treated limbs than in untreated 23 mm (11–34) versus 34 mm (25–44), $p < .001$). Sixteen of 31 re-interventions (51%) were caused by migration (10 at the distal landing site, 6 at interconnections), nine of 31 (29%) by disease progression, and nine of 31 (29%) had inadequate initial stent graft placement. Three of 31 re-interventions (10%) were done as proactive procedures.
Conclusions: Additional iliac stent grafting occurred late after primary repair; a considerable number were caused by rupture. A low degree of oversizing, migration at the distal landing site, separation of stent graft interconnections, disease progression at the distal landing site, and inadequate initial stent graft placement may all contribute. Patients with large iliac dimensions and short attachment zones may need a larger degree of oversizing and more vigorous surveillance.

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INTRODUCTION

Today, endovascular aortic repair (EVAR) is an accepted—and often preferred—treatment for abdominal aortic aneurysms (AAAs). EVAR has lower early morbidity and mortality than open repair, but the incidence of re-interventions and late complications appears to be higher after EVAR,[1–8] although contradictory reports exist.[9] Since its introduction, the EVAR technique has been developed further with proximal anchoring, easier deployment, and smaller diameter introducers.[10,11] The improved proximal stent graft fixation was introduced after reports of migration leading to proximal type 1a endoleaks.[12,13] The introduction of stent grafts with proximal barbs and hooks did not abolish migration related EVAR re-interventions, and late ruptures after EVAR still occur at a frequency of around 1%.[14] The causes of late ruptures are still most often type I and type III endoleaks.[14] Of the re-interventions for type I endoleaks, those performed with additional iliac stent grafts

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are among the most frequent, but little has been published about their causes.[15] In this retrospective study, bridging stents at limb interconnections and distal extensions (from here on named additional iliac stent grafts) were included. The aim was to determine the underlying causes and to identify factors associated with additional stent grafting.

METHODS

Patients

All 439 patients (mean age 74.9 ± 7.4 years, 84.7% men) who were treated by standard bifurcated EVAR at Sahlgrenska University Hospital between 2005 and 2015 were included in this retrospective observational study. In addition, five patients with additional iliac stent grafts who had had primary EVAR before the study period ($n = 2$) and patients who were initially treated in other hospitals ($n = 3$) were included. Thus, a total of 444 patients were analysed. Juxta- and suprarenal aneurysms treated with fenestrated, branched, or chimney stent grafts were not included. The patients were divided into two groups, one group had a re-intervention with additional iliac stent grafting during follow-up ($n = 24$) and the other did not ($n = 420$). Patient characteristics are listed in Table 1.

The study was approved by the Research Ethics Committee in Gothenburg (number 508-14), which waived individual patient consent.

Study protocol

Pre-, per-, and post-operative data from patient records, institutional databases, and national registries were reviewed regarding primary repair, complications, and re-interventions. Follow-up consisted of computed tomography (CT) investigations 1 and 12 months post-operatively and annually thereafter.

Comparisons were done in three steps. First, baseline demographic data were compared in patients with additional iliac stent grafting ($n = 24$) and in patients without ($n = 420$). Secondly, all treated and untreated limbs in the study cohort were compared using pre-operative measurements from EVAR planning protocols. Thirdly, of the 24 patients who required additional iliac stent grafting, the treated limbs ($n = 30$) and untreated limbs ($n = 18$) were compared by doing a detailed analysis of post-operative CT scans. Stent graft oversizing was defined as the percentage difference in diameter between the chosen iliac limb and the common iliac artery proximal to origin of the internal iliac artery (stent graft diameter/Iliac artery diameter).

The detailed analysis was done on the first post-operative CT after EVAR and on the last CT obtained before the re-intervention, using a TeraRecon workstation (Foster City, CA, USA). Vessel lengths and migration distance were measured along the central lumen line (CLL), and vessel diameters were measured perpendicular to the CLL. The parameters evaluated were vessel diameter at the iliac landing zone, attachment length, common iliac artery lengths, angulation, and migration.

Table 1. Patients with and without re-interventions with additional iliac stent grafts after EVAR. Mean and standard deviation, median and 25th—75th percentiles, or number (%).

	Patients without additional iliac stent graft re-intervention ($n = 420$)	Patients treated by additional iliac stent graft re-intervention ($n = 24$)	p
Age	75.0 (7.4)	73.0 (7.4)	.18
Male gender	352 (83.8%)	24 (100%)	.03
BMI	27.4 (5.5)	29.3 (4.4)	.41
Type of aneurysm			.81
Atherosclerotic	395 (94.3%)	23 (95.8)	
Inflammatory	11 (2.6%)	1 (4.2%)	
Mycotic	12 (2.9%)	0	
Other	1 (0.2%)	0	
Ruptured aneurysm before primary intervention	76 (18.1%)	3 (12.5%)	.49
AAA diameter	64 (58—74)	64 (57—75)	.80
Serum creatinine (μmol/L)	92 (78—111)	87 (70—110)	.66
Diabetes mellitus	71 (17.0%)	3 (13.0%)	.62
Known pulmonary disease	92 (22.2%)	6 (26.1%)	.66
Concomitant cardiac disease	192 (46.0%)	8 (34.8%)	.29
Dialysis	12 (2.9%)	1 (4.3%)	.69
Previous cerebral infarction/TIA	54 (13.0%)	1 (4.3%)	.22
Hypertension	297 (71.3%)	13 (56.5%)	.13
Stent graft			.22
Endurant	285 (68%)	7 (29%)	
Zenith	59 (14%)	10 (42%)	
Excluder	51 (12%)	2 (8%)	
Talent	11 (2.5%)	5 (21%)	
Zenith LP	9 (2%)	0	
Ovation	3 (1%)	0	
Incraft	2 (.5%)	0	

AAA = abdominal aortic aneurysm; BMI = body mass index; TIA = transient ischaemic attack.

The diameter of the iliac landing zone was measured at both its proximal and distal margin. Attachment length at primary repair was defined as the distance of circumferential contact between stent graft and vessel wall along the CLL. Attachment lengths were related to the instructions for use (IFU) of the respective stent graft used. Angulations were measured along the CLL as previously described by van Keulen et al.[15] for supra- and infrarenal angulations. Three different iliac angulations were measured: (1) the maximum angle between the proximal infrarenal aortic neck and the distal end of the iliac stent graft; (2) the maximum angle between the iliac stent graft at the level of the main body flow split and the distal end of the iliac stent graft; and (3) the maximum angle at any level along the iliac stent graft. Migration was measured along the CLL and defined as an increased distance from the origin of the internal iliac artery of >5 mm and a corresponding reduced distance from the aortic bifurcation to the end of the stent graft during follow-up. In cases with a landing zone in the external iliac artery, a