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Mid- and Longer-term Follow up of Chimney and/or Periscope Grafts and Risk Factors for Failure

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WHAT THIS PAPER ADDS

Long-term follow up of chimney and periscope grafts for the treatment of pararenal and thoraco-abdominal aortic aneurysm is presented. This approach using off the shelf devices has been increasingly reported in recent years and with good results even in emergent settings. This risk factor analysis showed that inadequate branch graft length and chimney and periscope use in small and diseased target arteries contribute to late failure of this technique.

Objective: The aim was to report on chimney and periscope grafts (CPGs) and their mid- and longer-term outcomes when they are used to preserve reno-visceral artery (RVA) perfusion in endovascular repair of pararenal (PRAAs) or thoraco-abdominal aortic aneurysm (TAAAs). In addition, factors associated with CPG failure are presented. Limited data exist on the outcomes of CPGs, and mid- and long-term results are generally not reported.

Methods: This was a prospective study in a cohort of 100 patients with PRAA (69) or TAAA (31). A total of 224 (mean 2.24 per patient) RVAs were preserved with 136 (61%) chimney and 88 (39%) periscope grafts. CPGs were constructed mainly using self expandable stent grafts. Patients were followed by clinical examination, CTA (82%), and/or duplex (18%). Data were collected until February 2015.

Results: CPG immediate technical success was 99% (222/224 branches). Mean follow up was 29 months (range 0–65; SD 17); 59% patients were followed $>$ 2 years, 30% $>$ 3 years, and 16% $>$ 4 years. Post-operatively, CPG occlusion was observed early ($\leq$30 days) in three (1.3%) branches and during follow up in 10 (4.5%). At 36 and 48 months, the estimated primary patency was 93% and 93%. After corrective percutaneous (10) or surgical (3) re-interventions, the estimated secondary patency was 96% and 96%. Thirty day mortality was 2%; at 36 and 48 months the estimated patient survival was 79%. Significant shrinkage (72 [SD 23] vs. 62 [SD 24] mm; $p < .001$) was observed, with a substantial reduction (>5 mm) in 55 patients, and sac enlargement in four. Incomplete aneurysm sac sealing was treated successfully by a secondary intervention in 15 patients.

Conclusions: Self expandable CPGs have proved to be a highly successful and durable treatment for RVA preservation up to 5 years. Incomplete CPG expansion, inadequate length, and CPG use in small and diseased target arteries were risk factors for occlusion. These mid- and longer-term results support CPG use to treat PRAAs or TAAAs in patients unfit for open surgery or fenestrated/branched stent grafts.

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INTRODUCTION

Endovascular treatment of pararenal abdominal aortic aneurysms (PAAAs) and/or thoraco-abdominal aortic aneurysms (TAAAs) is usually performed using fenestrated or branched stent grafts (B/FEVAR).[1] However, because of anatomical limitations, device non-availability, and time consuming customization, a significant number of patients are excluded from B/FEVAR.[2] To overcome these limitations,

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parallel graft techniques using a combination of off the shelf devices have been developed to fit most of such complex cases.[3] Unfortunately, until now data published on chimney and periscope grafts (CPGs) have been limited, especially with regard to long-term results. In order to add supportive data on the value of this technique, mid- and longer-term outcomes of over 4 years of CPGs used in a single center over an 8 year experience are reported. This series includes 100 consecutive patients treated by CPG techniques in an intention to treat protocol, with standardized implantation methods and follow up protocols.

METHODS AND PATIENTS

This was a single center retrospective analysis of prospectively gathered data from 100 patients deemed unsuitable for conventional surgery and treated from January 2008 to August 2013 with at least one renal or visceral chimney or periscope graft. A vascular board including a cardiovascular surgeon and interventional radiologist selected patients. Briefly, patients with low surgical risk (good anatomy for clamping and grafting; young with unrestricted organ function, especially normal heart, lung and renal function) were treated by open surgery.[4] Patients presenting high risk for conventional surgery were treated by hybrid repair techniques (approximately 70–80% of all open repairs), and patients at high surgical risk for open surgery and/or unfit for fenestrated endovascular devices were treated endovascularly with parallel graft techniques. During the study period most patients presenting with aortic aneurysms involving the visceral aorta were treated by the hybrid repair technique (20%) or completely endovascularly (50%). Overall, 10 custom made branched/fenestrated grafts were used. Conventional open surgery was performed in the remaining 30% of cases. This series included 69 PAAAs (no normal aorta between the origin of the aneurysm and the lowest renal artery) and 31 TAAAs.[5] Eight TAAAs extended to the aortic arch. Seventy-three (73%) patients were treated electively and 27 (27%) non-electively (12 ruptured cases). Demographics and comorbidities[5–8] are reported in Table 1.

Investigational informed consent for the procedure and study was obtained from all patients. Clinical data were collected with the university hospital clinical information system (Dendrite, Dendrite Clinical Systems, Ltd, Henley-on-Thames, UK; KISIM 4.901, CISTEC AG, Zurich, Switzerland) and updated in February 2015. Earlier data with shorter follow up for some of these patients have been published previously.[3]

Standardized protocol

An aortic board reviewed all cases pre-operatively to assess CPG feasibility. Pre-operative thoraco-abdominal computed tomographic arteriography (CTA) was performed in all patients. CTA images were analyzed with the 3mensio software (3mensio Medical Imaging BV, Bilthoven, The Netherlands) to assess disease extent, and aortic and branch dimensions and angulations. The material necessary

Table 1. Demographics, comorbidities, and operative details.

Patients		100
Female		21
Mean age		73 ± 9
Hypertension		89
Diabetes		16
Lipid disorders		43
COPD		57
CAD		57
ASA class III/IV		62
class V		27
PAD		42
Hostile Chest/Abdomen		60
Mean GFR at baseline		54 ± 13
GFR<60		46
ESRF		12
Dialysis		5
Pre-operative aneurysm maximal transverse diameter (mm)	Mean, Median, Range	71.76 ± 23, 65, 38–185
Aortic aneurysm type	Pararenal	69
	Suprarenal	25
	Thoraco-abdominal	31
	Crawford I	7
	Crawford II	4
	Crawford III	3
	Crawford IV	9
	Arch to visceral	8
Operation	Elective	73
	Non-elective	27
	Symptomatic	15
	Ruptured	12
Number of CPG	1	21
	2	47
	3	19
	4	13
Main aortic stent graft	Diameter (mm)	33 ± 5
	Excluder and TAG[a]	55
	Endurant and Talent[b]	27
	Evita[c]	17
	Zenith[d]	1
In hospital stay (days)	Mean	10 ± 10
Intensive care unit stay (days)	Mean	2 ± 4
	Median	0
	Range	0–24

Note. Comorbidities were defined according to the Ad Hoc Committee for Standardized Reporting Practices in Vascular Surgery of the Society for Vascular Surgery and the American Association for Vascular Surgery; Juxtarenale, suprarenale und Abschnitt-IV-Aneurysmen classification; the Rutherford classification; and the National Kidney Foundation. COPD = chronic obstructive pulmonary disease; GFR = glomerular filtration rate (mL/min/1.73 m^2); CAD = coronary artery disease; ASA = American Society of Anesthesiologists; PAD = peripheral artery disease; HC/HA = hostile chest/hostile abdomen (previous surgical intervention with open chest or open abdomen); pararenal = juxta- and supra-renal; thoraco-abdominal = all descending aortic aneurysm, including those extending inside the aortic arch; CPG = chimney and periscope graft; ESRF = end stage renal function.

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