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CASE REPORT

Parallel Graft Technique in a Complex Aortic Aneurysm: The Value of Intra-operative Flexibility from The Original Operative Plan

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Introduction: The parallel grafting technique (PGT) is a valuable alternative to prefabricated branched or fenestrated endovascular aortic repair. An often overlooked advantage of PGT is its unique adaptability to different anatomical challenges that might appear intra-operatively.
Report: A 72 year old male patient presented with a 60 mm thoracic aneurysm, 59 mm juxtarenal abdominal aortic aneurysm, and 32 mm common iliac aneurysm (CIAA). Thoracic endovascular aortic repair plus endovascular aortic repair with bilateral renal artery chimneys and CIAA exclusion applying the sandwich technique was proposed. Because of unfavourable angulation it was not possible to achieve selective left renal catheterisation via axillary access. Changing to a femoral approach allowed successful retrograde catheterisation. The procedure ended with a chimney for the right renal artery and a periscope for the left renal artery. The final angiogram showed no endoleaks and renal and hypogastric patency. The patient was discharged three days after the procedure and remains under ultrasound surveillance after 40 months because of a small type two endoleak.
Conclusion: When using a prefabricated branched device, the possibility of selectively catheterising a visceral branch often has no straightforward solution. However, parallel grafting is an extremely flexible technique, which was of paramount importance for the surgical outcome of the present case.

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INTRODUCTION

Since the original description in 2003 by Greenberg et al.[1] and later adaptation by Criado in 2007,[2] parallel graft techniques (PGT, use of covered stents in aortic side branches parallel to and outside the abdominal endograft) have been gaining popularity worldwide. Because it can be deployed in several different ways, the originally described modality, also known as the chimney or snorkel (ch-EVAR), has been adapted to adjust to multiple endovascular settings. The periscope technique (reversed chimney from transfemoral access) introduced by Lachat et al., in 2008,[3] and the sandwich technique described by Lobato in 2011,[4] are examples of internationally accepted methods that take advantage of parallel grafts to treat complex aortic and iliac aneurysms.

PGT can be performed with "off the shelf" materials, with important economic and time related advantages and acceptable peri-operative outcomes. Current published evidence shows promising clinical and radiological results,[5] with no significant differences in terms of early mortality and post-operative dialysis compared with fenestrated endografting.[6]

An often overlooked advantage of PGT is its distinctive ability to adapt to different anatomical challenges that can occur intra-operatively. This report describes a challenging case with three year follow up of treatment of a thoracic aortic aneurysm (TAA), juxtarenal abdominal aortic aneurysm (AAA), and common iliac artery aneurysm (CIAA), in which the intra-operative PGT adjustability was of paramount importance to surgical outcome.

CASE REPORT

A 72 year old male patient, with a history of type 2 diabetes, hypertension, dyslipidaemia, smoking, and abusive alcohol consumption, was referred following the incidental CT scan diagnosis of a 60 mm TAA, 59 mm juxtarenal AAA, and 32 mm CIAA (Fig. 1, Video 1). Thoracic endovascular aortic repair (TEVAR) plus endovascular aortic repair (EVAR)

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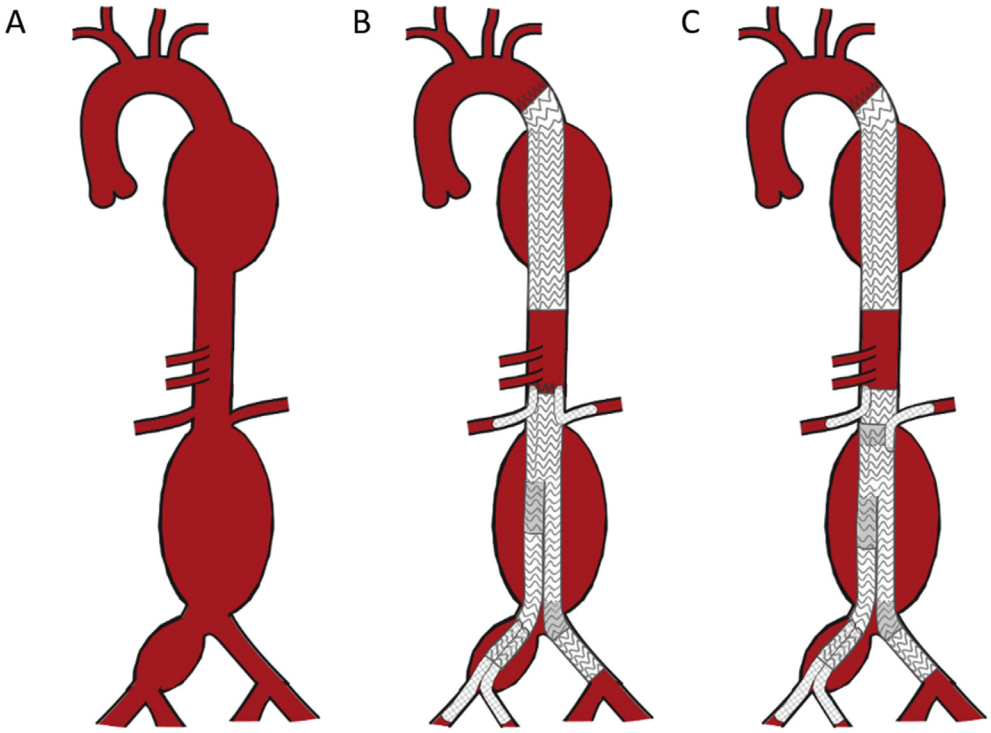

Figure 1. Schematic of patient's anatomy and proposed treatment strategy. (A) 60 mm TAA, 59 mm juxtarenal AAA, and 32 mm CIAA. (B) First treatment strategy. TEVAR plus chEVAR with bilateral renal artery chimneys and CIAA exclusion with preservation of the hypogastric artery applying the sandwich technique. (C) TEVAR plus chEVAR, with a chimney for the right renal artery and a periscope for the left renal artery with an additional aortic stent applied in the neck, and CIAA exclusion with preservation of the hypogastric artery applying the sandwich technique.

with bilateral renal artery chimneys and CIAA exclusion with preservation of the hypogastric artery applying the sandwich technique was planned, with both renal artery and hypogastric artery selective catheterisation via an axillary approach (Fig. 1). Because of unfavourable angulation, it was not possible to maintain a rigid guidewire in the left renal artery. After several unsuccessful attempts, and to avoid iatrogenic left renal artery trauma that would make impossible new selective catheterisation of this branch, the initial plan changed. The left renal artery was catheterised by a femoral approach, and, instead of bilateral renal artery chimney grafts, a chimney for the right renal artery and a periscope for the left renal artery with an additional aortic stent applied in the neck was performed (Fig. 1). The final angiogram showed no endoleaks and renal and hypogastric patency (Video 2).

Supplementary video related to this article can be found at https://doi.org/10.1016/j.ejvssr.2019.03.002

The following are the supplementary data related to this article: Video 1Pre-operative CT scan showing a 60 mm thoracic aorta aneurysm (TAA), 59 mm juxtarenal abdominal aortic aneurysm (AAA), and 32 mm common iliac artery aneurysm (CIAA)1.

Video 2Final angiogram showing aneurysm exclusion and visceral patency. Right renal artery perfused by a chimney stent and left renal artery by a periscope stent. A sandwich technique was used to preserve the right hypogastric artery.

The femoral arteries were exposed surgically, with the main body of the aortic stents deployed from the left. The thoracic stent graft was a 40×40×200 mm Valiant Captivia (Medtronic), and the aortic stent graft was a 32×16×145 mm Endurant II + 36×36×70 mm aortic extension (Medtronic); ipsilateral iliac extension 16×16×82 mm; and contralateral iliac extension 16×16×124 mm. For both renal arteries 6×50 mm self expandable covered stents (Viabahn, Gore) reinforced with 7×60 mm self expandable nitinol stents (Complete, Medtronic) were deployed. A sandwich technique was performed to preserve the right hypogastric artery with 7×100 mm self expandable covered stents (Viabahn, Gore) for IIA and a 16×10×93 mm Endurant II iliac extension for the external iliac artery. The surgery was performed under local anaesthesia, with a 211 min operation time and using 115 mL of iodine contrast. Output data from the fluoroscope machine log registered peak skin dose of 6.1 Gy and reference air kerma 7.1 Gy, with 58 min of fluoroscopy time. A single dose of 5000U unfractionated heparin followed by 2500U for every two h of surgery was applied. ACT time is not routinely monitored.

The patient was discharged three days after the procedure on antiplatelet therapy (acetylsalicylic acid 150 mg daily). After the 30 day CT scan, he was monitored only by duplex scan because of worsening chronic kidney insufficiency. The duplex performed persistently described sac stability and no endoleaks until January 2018, when a small increase in sac diameter was reported. For that reason,

another CT scan was performed in April 2018 (Fig. 2 and Video 3), which revealed a small type 2 endoleak and sac growth from the original 59 mm to 67 mm.

Because of the stage 4 CKD (presumably related to severe hypertension and type 2 diabetes), further endovascular intervention and surveillance were not planned. The last ultrasound, in January 2019, showed no additional sac growth, which remained 66 mm in diameter. This conservative approach is in line with recent ESVS recommendations considering intervention in type2 endoleaks only when the sac grows >10 mm.[7] The patient remains asymptomatic after 40 months of follow up.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.ejvssr.2019.03.002

The following is the supplementary data related to this article: Video 3Three year CT scan showing correct stent placement, renal and hypogastric artery patency and a small type 2 endoleak3.

DISCUSSION

The efficacy of the snorkel/chimney approach in EVAR has been demonstrated in several reports[8] and corroborated by a large multicentre study.[9] Even the main criticism of the technique, related to the perceived increased incidence of early gutter related type Ia endoleaks, has been put into question in an interesting work by Ullery and colleagues,[5] which suggests that its natural history may be more benign than originally thought. Such endoleaks appear to resolve spontaneously in the majority of cases during early to midterm follow up, seldom require re-intervention, and do not correlate with increased risk of aneurysm sac growth.[5]

With encouraging results and significant economic and time related advantages using "off the shelf" materials, it is no surprise that PGT is gaining popularity worldwide. An often overlooked advantage of this technique is its capacity to adapt to different anatomical challenges that can occur intra-operatively. Whereas with a branched endograft switching from brachial to femoral access would constitute a technical challenge,[10] using PGT the surgeon can easily make an adjustment intra-operatively (Fig. 1). The periscope vs. chimney stent in PGT should be decided on a case by case basis, as there are potential advantages of each technique depending on vessel anatomy with upward oriented arteries favouring periscope, and downward oriented arteries favouring chimney.

The economic advantage of treating this patient with PGT cannot be overlooked. This patient would require a thoracic stentgraft, a branched/fenestrated endograft, and an iliac branched device. With PGT, the patient was treated effectively using standard thoracic and abdominal aortic stent grafts and covered stents alone, with a comparable radiation dose and operation time.[11] There is evidence that a staged TEVAR and EVAR approach can reduce the risk of SCI in high risk patients.[12] However, in this case, with both subclavian and hypogastric arteries patent and a significant portion of the visceral aorta not covered, SCI was not a problem. Additionally, despite solid evidence, it is the senior surgeon's belief that PGT is associated with a lower complication risk because of transient flow in the gutters. The present authors decided on simultaneous surgery.

A steerable sheath would be a major advantage in these procedures, but there was no such device available off the shelf at the time of this surgery. A major limitation of PGT remains the lack of standardisation. The maximum number of parallel grafts to deploy in each landing zone continues to be debated. Most agree that more than three is excessive and that the fewer, the better. There is no consensus on the best type of stent to use, although Viabahn is preferred by the authors because of its greater conformability. There is also an absence of formal recommendations on overlapping stent length. In this case, the overlap in the hypogastric sandwich was approximately 50 mm and the renal periscope 30 mm.

PGT is a complex procedure, and should not be viewed as a simpler form of branched or fenestrated EVAR. Significant

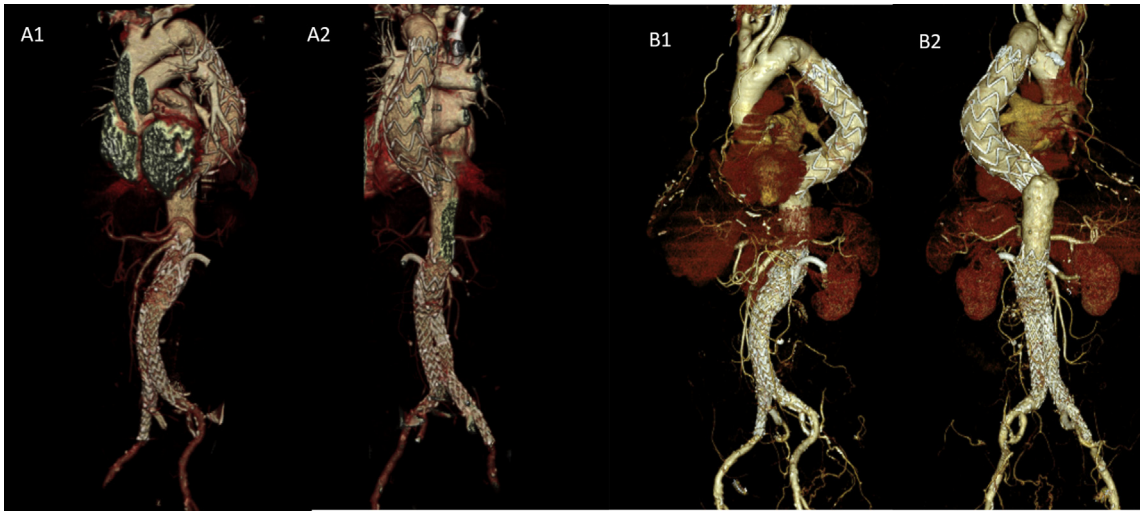

Figure 2. 3D reconstruction of follow up CT scans. (A1 and A2) one year follow up. (B1 and B2) three year follow up. The TEVAR plus chEVAR can be seen with the periscope for the left renal artery, and right common iliac artery aneurysm exclusion with hypogastric artery preservation by the sandwich technique.

experience and expertise is required for its successful performance. This procedure in particular was completed by a vascular team that performs >40 procedures a year. The three year CT follow up demonstrating correct aneurysm exclusion, stent patency, and no endoleaks (Fig. 2) contributes to the growing body of evidence on the efficacy and durability of PGT in the treatment of complex aortic pathology.

Conclusion

Despite its limitations, parallel grafting is an interesting and adaptable technique, which is a valid alternative for the treatment of complex aortic aneurysms. In this particular case, the flexibility of the PGT was of particular importance for the surgical outcome of the procedure.

CONFLICT OF INTEREST

None.

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