

CASE REPORT

Off the Shelf Thoracic Endovascular Aortic Repair with Sandwich Technique for the Treatment of a Thoraco-Abdominal Penetrating Aortic Ulcer

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Introduction: Penetrating aortic ulcers (PAUs) are the rarest subset of acute aortic syndromes, and a thoraco-abdominal (TA) location is uncommon. Endovascular surgery is considered first line treatment. Custom made branched/fenestrated endografts have been successfully applied in this disease but are unavailable in the urgent setting. Off the shelf solutions may be required in high risk patients. The case of a symptomatic rapidly expanding TA-PAU without a distal seal zone that underwent urgent endovascular repair is described.

Report: An 81 year old male presented with acute intense thoracic pain. Workup revealed a large TA-PAU. As pain was refractory and computed tomography angiography confirmed rapid expansion, urgent repair was proposed. Due to multiple comorbidities and absence of adequate distal seal zone, an off label endovascular treatment was proposed. The patient underwent successful endovascular repair with two aortic stent grafts (GORE cTAG) with 30% oversize and 50–55 mm overlap between modules, combined with chimney self expanding stent grafts (GORE VIABAHN) to the coeliac trunk and superior mesenteric artery in a sandwich configuration. The post-operative course was uneventful. Follow up at 18 months revealed no endoleaks and patent bridging stent grafts without visceral compromise.

Discussion: Thoracic endovascular aortic repair (TEVAR) is considered the first treatment option for urgent PAU. However, anatomic requirements limit its use in the thoraco-abdominal aorta. Parallel graft techniques have been described to overcome these anatomic constraints in TA aneurysms. The use of a “sandwich technique” to successfully exclude a PAU without a distal sealing zone for standard TEVAR is described. The advantage was limited aortic coverage compared with a branched device or an “octopus” technique. This solution is particularly useful in urgent situations when patients cannot wait for a custom made device and the morbidity associated with open or hybrid repair is unacceptably high. An off the shelf sandwich technique is a potential safe and long lasting therapeutic option for the urgent treatment of TA-PAU.

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INTRODUCTION

Penetrating aortic ulcers (PAUs) are the rarest subset of acute aortic syndromes and a thoraco-abdominal (TA) location is seen in only 14% of cases.¹ As with other locations, endovascular treatment of TA-PAU is non-inferior to open or hybrid repair and is the standard of care in this fragile group of patients with complicated PAU.²

Custom made branched/fenestrated endografts have been used to treat para-visceral aortic PAUs.³ However, the waiting time associated with manufacturing makes these

inaccessible in urgent or emergency settings, making an off the shelf solution the only option in patients with prohibitive open surgical risk.

An endovascular solution using two standard thoracic endovascular aortic repair (TEVAR) stent grafts and two parallel stent grafts in a sandwich configuration, allowing distal sealing and preservation of visceral perfusion is described.

CASE REPORT

An 81 year old male with an history of hypertension, hyperlipidaemia, and hypothyroidism was admitted to the emergency department with four days of intense pleuritic back pain, no precipitating factors, and mild pain relief with analgesics. Physical examination revealed a conscious, afebrile patient, with a blood pressure of 160/80 mmHg and a heart rate of 100 bpm. Cardiopulmonary examination was otherwise normal. The abdomen was unremarkable and all

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peripheral pulses were present and symmetrical. Blood workup revealed only a mildly elevated D dimer. Computed tomography angiography revealed a TA-PAU with a depth and diameter of 20 mm, and without rupture signs, and visceral vessel patency.

The patient was admitted to intermediate care and started successful blood pressure control with beta blockers and pain management. After 48 hours, the symptoms recurred, and computed tomography angiography was repeated. A rapidly expanding TA-PAU, 13 mm above the coeliac trunk with a 32 × 30 mm pseudoaneurysm with contained rupture was noted (Fig. 1A), and urgent repair was proposed. Since the patient was considered high risk for open or hybrid repair and there was no adequate distal seal zone for TEVAR, an off the shelf endovascular technique was proposed. A TEVAR with sandwich technique to the coeliac trunk and superior mesenteric artery was planned, in order to exclude the PAU and perfuse the visceral arteries.

Under general anaesthesia, bilateral percutaneous femoral and open left axillary access were obtained. The patient was fully heparinised (7 500 IU). A thoracic

endograft (GORE cTAG) 26 × 100 mm was deployed just above the ostium of the coeliac artery through the right femoral access. Through two separate punctures of the axillary artery, the coeliac trunk and superior mesenteric artery were cannulated, and 7F and 8F sheaths, respectively, were progressed into the arteries. Two self expandable stent grafts (GORE VIABAHN) 7 × 100 mm and 8 × 150 mm, respectively, were put in position in a chimney configuration, taking care not to occlude unnecessary side branches, while keeping the stents aligned at the top. A second TEVAR stent graft (GORE cTAG) 34 × 100 mm (30% oversizing) was deployed, extending the distal seal zone to the ostium of the highest renal artery, in a sandwich configuration, ensuring the bridging stents were positioned a few millimetres above the proximal edge of the second device, obtaining around 50–55 mm of overlapping modules. Finally, sheaths were retracted, and bridging stent grafts were deployed and post-dilated with a non-compliant balloon, following inflation of the thoracic stent graft with a moulding compliant balloon. Final angiography confirmed PAU exclusion and antegrade visceral vessel perfusion, without endoleaks. The patient spent 48 hours in the intensive care unit, with complete remission of symptoms, and was discharged home on the fifth post-operative day with dual antiplatelet and statin therapy. The post-operative course was complicated by transient delirium, but otherwise uneventful. At 18 months, the patient was asymptomatic and computed tomography angiography revealed complete PAU thrombosis and involution with patency of the visceral vessels (Fig. 1B).

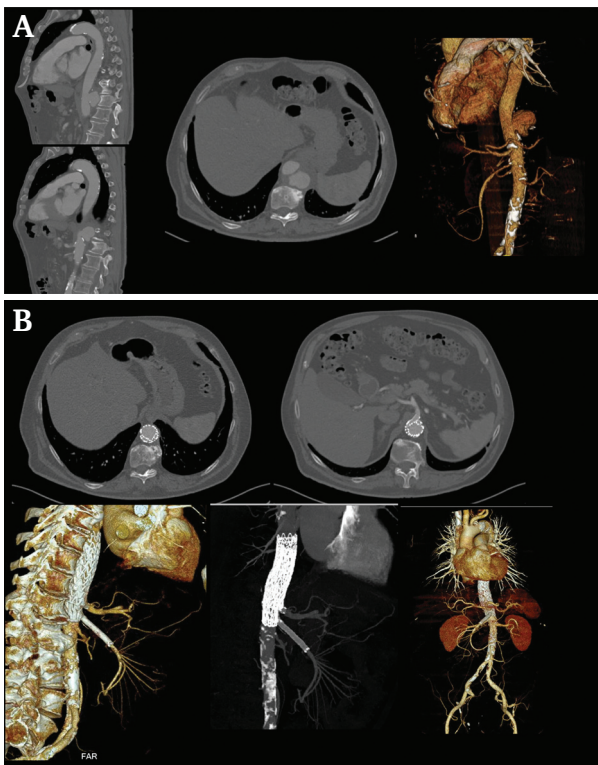


Figure 1. (A) Thoraco-abdominal transition penetrating aortic ulcer (PAU) sagittal views showing a wide neck thoraco-abdominal (TA)-PAU with short distal seal zone. Axial view revealing TA pseudoaneurysm with contained rupture. 3D volume rendering reconstruction of the patient thoraco-abdominal aorta. (B) Follow up computed tomography angiography (18 months) (axial views and 3D volume rendering reconstructions) revealing total thrombosis and involution of TA-PAU and patency of the thoracic endograft and the stents implanted on visceral branches.

DISCUSSION

PAU is a focal ulcerative lesion that usually develops adjacent to an atheromatous plaque. In complicated cases (refractory symptoms, accelerated growth, aneurysmal degeneration, impending or ruptured cases) surgical treatment should be offered. Due to its focal and segmental nature, PAU usually presents as a favourable lesion for stent grafting, but dependent on strict anatomic requirements.^{1,2} An inadequate landing zone due to proximity to visceral vessels, as in this case, presents an important limitation to standard endovascular techniques. In a thoraco-abdominal/para-visceral location, there are reports of favourable short and midterm outcomes with custom made branched/fenestrated endografts, but with a long manufacturing time.³ In the current case, this was not an option, and since the patient was unfit for open repair, an off label, off the shelf endovascular solution was needed, such as T branch, physician modified endografts (PMEG) including *in situ* antegrade laser fenestrations, chimneys/snorkels/periscopes (CHIMPS) or an Octopus technique.

First described by Greenberg *et al.* as a bailout for accidental renal artery coverage during endovascular aortic repair, there is evidence of CHIMPS in multiple clinical settings with acceptable results.⁴ The sandwich technique, introduced in 2008 by Lobato *et al.*, was developed to

overcome anatomical device constraints in iliac aneurysms, allowing preservation of pelvic flow.⁵ Later, it proved effective for the treatment of arch and thoraco-abdominal aortic aneurysms.⁶

In this case, there was a short lesion with healthy proximal and distal aortic segments, just limited by a short distal landing zone. The use of chimneys associated with TEVAR allowed distal extension and sealing without compromising visceral perfusion, and the sandwich technique ensured an adequate distal sealing zone and PAU exclusion, minimising the risk of endoleaks. The main advantages of this solution were limited aortic coverage and long overlap of the “sandwiched” bridging stents, reducing the chance of proximal endoleaks. Other off the shelf branched solutions were considered, either by using a T-branch device, PMEG, or an “octopus” technique.^{7,8} These would have required more extensive aortic coverage, thereby increasing the risk of paraplegia. In the case of a T branch device, the narrow lumen and need for either two branch occlusion or revascularisation of the renal arteries were also important limitations. Concerning PMEG, in particular *in situ* antegrade laser fenestrations, despite limited aortic coverage, the non-availability of a specific laser fibre, the risk of temporary visceral ischaemia, the higher risk of type 3 endoleak, and lack of experience precluded the use of this technique.

The use of self expanding stent grafts as bridging stents is debatable. Other authors have preferred balloon expandable stent grafts, due to higher radial force. However, the deformability forces that these stents may be subjected to over time may be significant, and a self expanding stent may offer greater long term resistance to kinking. In an *in vitro* study by Mestres *et al.*, a combination of Excluder and Viabahn stent grafts with 30% oversizing seemed the best in the two or three chimney configuration.⁹ Although evidence in thoracic aorta is scarce, other authors have preferred the GORE cTAG/Viabahn combination for “sandwich procedures”.¹⁰ The disadvantage of this configuration is the risk of bridging stent graft compression, which could be considered in this patient. This could be reduced by relining with a second self expandable bare stent.

In conclusion, an effective off the shelf solution for complicated TA-PAU in an emergency setting is presented. Early and midterm success and the lack of serious perioperative complications are encouraging. This solution

offers limited aortic coverage and the possibility of visceral aortic debranching in case of chimney failure.

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None.

CONFLICTS OF INTEREST

None.

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