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CASE REPORT

Aortic Rupture During a Staged Endovascular Repair of a Thoracoabdominal Aneurysm

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Introduction: The management and outcome of a patient with a type III thoracoabdominal aortic aneurysm (TAAA) are reported.
Methods: The patient was scheduled for a two-stage endovascular repair strategy but experienced a contained TAAA rupture a week before the planned second stage fenestrated endovascular repair that had been postponed from 6 weeks to 5 months.
Results: Fortunately, the fenestrated device had already been delivered to the hospital; the contained rupture was thus managed endovascularly in this high-risk patient.
Conclusion: Staging extensive TAAA repairs to reduce the incidence of spinal cord ischemia is associated with a risk of interval aneurysm rupture.

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INTRODUCTION

Endovascular aortic repairs using branched and fenestrated devices are now an accepted alternative to conventional open surgery in the treatment of extensive thoracoabdominal aneurysms (TAAAs). Despite being a minimally invasive approach, these complex procedures are nonetheless associated with an appreciable risk of spinal cord ischemia (SCI).[1] The most important risk factor for SCI is the length of aortic coverage by the endograft. However, the concept of an anterior spinal cord vascular collateral network has been mooted. This extensive system includes subclavian arteries proximally and hypogastric vessels distally.[2,3] This concept embraces the idea of a remodelling process driven by pressure gradients across paraspinal collaterals. It offers the hope that a "staged approach" to extensive and complex endovascular aortic repair has the potential to reduce SCI by arteriogenic preconditioning — the stimulation and growth of the anterior spinal collateral network.[4] However, in the management of these complex scenarios, the risk of aneurysm rupture during the interval between the procedures has to be balanced against the risk of paraplegia.

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CASE REPORT

A 75-year-old male patient presented with a Crawford type III TAAA. The maximum aortic diameter was 70 mm (Fig. 1). Comorbidities included type 2 diabetes mellitus, hypertension, dyslipidaemia, and chronic obstructive pulmonary disease. Preoperative assessment was unremarkable. Computer tomography angiography (CTA) showed aortic anatomy suitable for a staged endovascular approach, including a temporary distal thoracic landing zone above the coeliac trunk. We planned a two-staged repair comprising a first-stage thoracic endograft (from the left subclavian artery [LSA] origin to the temporary distal thoracic landing zone) and a delayed abdominal fenestrated repair 6 weeks later.

First stage

In accordance with our previously published protocol,[5] a cerebrospinal fluid drain was inserted the day before the procedure. The endovascular procedure was performed in a dedicated hybrid operating room (Discovery, GE Healthcare, Chalfont St Giles, UK) under image fusion guidance. Under general anaesthesia and systemic heparinization (50 UI/kg), two thoracic endografts were implanted via a transfemoral approach (ZTEG 2P-38-152-PF and ZTEG 2P-38-202PF, Cook Medical, Bloomington, IN, USA). The first component was implanted just distal to the LSA origin and the distal thoracic component was implanted just above the coeliac trunk. Completion angiography and postoperative CTA showed the

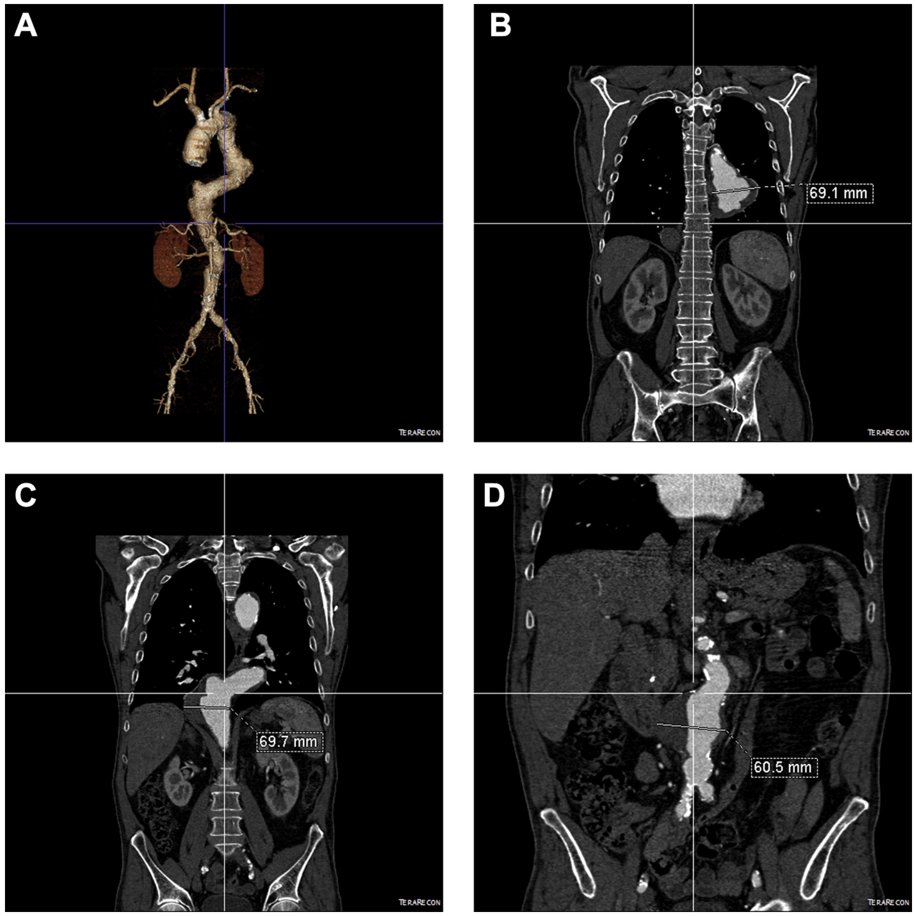

Figure 1. Pre-operative computed tomography three dimensional volume rendering (A) and multiplanar reconstructions showing a 70 mm bifocal thoracic aneurysm (B,C), and a 60 mm juxtarenal aneurysm (D).

expected type IB endoleak (Fig. 2). Procedure was accomplished with 60 mL of iodinated-contrast, 5 minutes of fluoroscopy time, and a dose area product of 1.870 cGy/ cm^2. Three days post procedure, the patient experienced a non-ST segment elevation myocardial infarction (N-STEMI), with an isolated increase in the tropinin level but no chest pain. Cardiac catheterization showed multivessel coronary disease. The patient underwent a three-vessel coronary artery bypass graft 3 weeks later. This serious complication caused delay on the planned second stage procedure. The initially scheduled interval of 6 weeks ultimately stretched to a total of 5 months.

Urgent second stage endovascular procedure

Seven days before the planned admission for the second endovascular procedure, the patient was referred to our emergency department with acute thoracic pain. Further CTA revealed a contained aortic rupture in the distal thorax. The maximum aortic diameter had increased from 70 mm to 90 mm (Fig. 3). The patient was haemodynamically stable. Fortunately, the custom made device (CMD) had already been delivered to the hospital and it was possible to proceed according to the original plan.

In our hybrid room and under fusion guidance and full anticoagulation, the fenestrated component was implanted through a transfemoral approach. The target vessels were cannulated, stented, and the stents were flared in standard fashion. A bifurcated body and limb extension were then implanted to complete the repair. The proximal sealing zone was in the distal part of the previous thoracic endograft and the distal sealing zone in the common iliac arteries. Postoperative CTA (Fig. 4) showed that all target vessels were patent and that there was no endoleak. Technical success was confirmed by a postoperative contrast-enhanced ultrasound examination.

The postoperative course was unremarkable. The patient was discharged home on the seventh postoperative day. There were no neurological complications and renal function was normal.

DISCUSSION

We report a case of aortic aneurysm rupture occurring in the interval between planned stages of an endovascular repair of an extensive type III TAAA. The TEVAR first-stage procedure can be performed with commercially available endografts and is thus usually scheduled as soon as possible. The second stage fenestrated procedure is performed 6—8 weeks after TEVAR. The interval of approximately 6 weeks between stages coincides with the delay imposed by CMD manufacturing constraints. In this case,

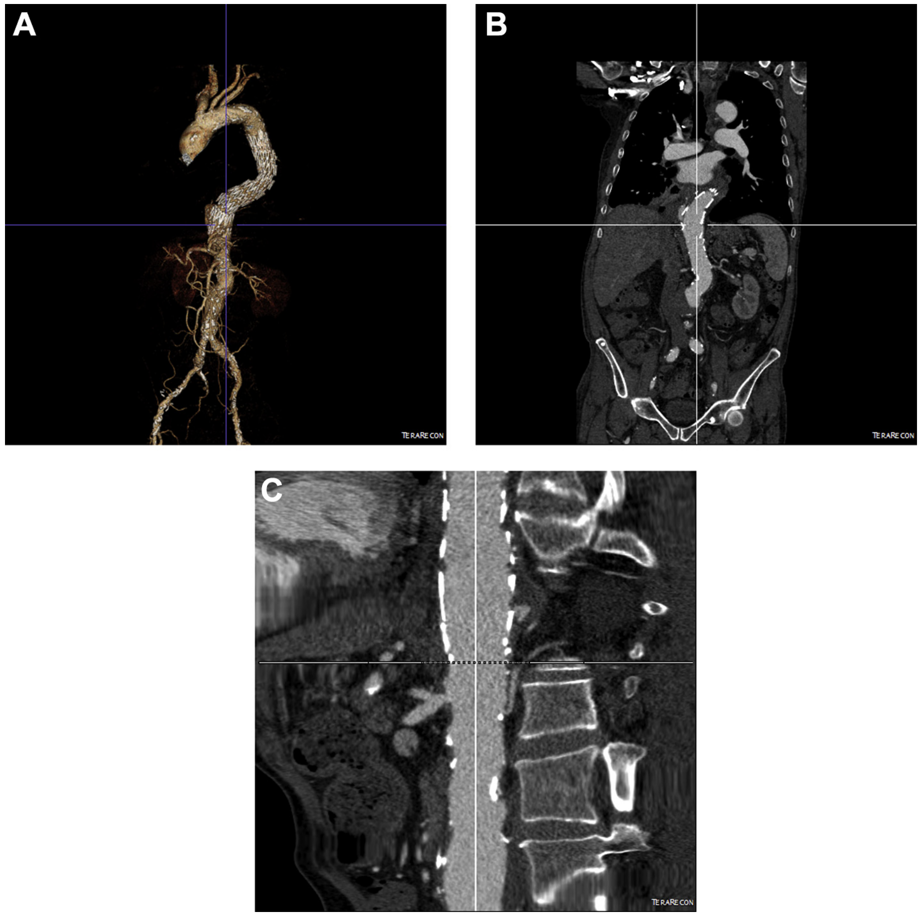

Figure 2. A distal type I endoleak is shown after the first procedure on the computed tomography three dimensional volume rendering (A) and sagittal (B) multiplanar reconstructions. The stretched curved planar reconstruction (C) confirms that the distal end of the thoracic endograft is positioned just above the origin of the celiac trunk.

the second stage was considerably delayed because stage 1 was complicated by an acute coronary syndrome requiring cardiac surgery. Fortunately, the four-fenestration CMD endograft was available when the aneurysm ruptured and this allowed successful expedited surgery.

The mechanisms that lead to SCI are thought to include infarction secondary to absolute low perfusion (loss of intercostals and poor collateral supply); reperfusion injury after transient per-procedural low perfusion; micro-embolic “trash” arising from intra-aortic manipulation. The first two

Figure 3. Computed tomography sagittal multiplanar reconstruction of the contained distal thoracic rupture.

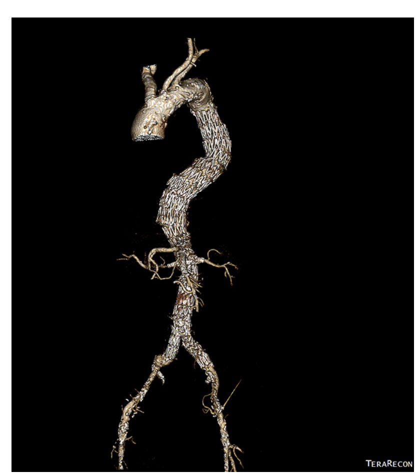

Figure 4. Three dimensional volume rendering reconstruction of the post-operative computed tomography following urgent fenestrated repair.

are theoretically available to modification — essentially by optimisation of the factors that underpin Starling's forces.[6–9] They can be grouped into factors that directly or indirectly reduce flow/pressure in the anterior spinal artery (length of aortic coverage, poor internal iliac arteries, LSA occlusion, hypotension), and those that reduce the oxygen carrying capacity of the blood (blood loss/anaemia/hypoxia). As a consequence, our current strategies when performing extensive TAAA repairs, in addition to CSF drainage, are to stage procedures and to preserve collateral flow.

Our current practice is to implant thoracic endovascular components during the first session of staged procedures only in patients with a marginal distal thoracic sealing zone (with a maximum diameter $<$ 42 mm). In this scenario, distal type I endoleaks (IB) are to be expected. Nevertheless, such leaks do not preclude thrombosis of the bulk the thoracic aneurysm, which is the goal of the first procedure. These initial procedures are usually performed 6 weeks before fenestrated endografting. The interval is chosen in the hope of allowing spinal collateralisation while minimising the risk of interval aneurysm rupture.[6,7]

In a meta-analysis, Canaud et al.[10] reported six cases of aneurysm rupture during staged hybrid TAAA repair. In the case illustrated, the delay was considerably lengthened because of the need for cardiac surgery, aortic rupture occurred and it was a matter of the greatest good fortune that the patient was stable and that the graft was available!

CONCLUSION

Staging extensive TAAA repairs to reduce the incidence of SCI is advocated, but interval aneurysm rupture is a real possibility, particularly if the delay is prolonged. Whenever possible, it is recommended to use the window of planning and manufacturing correctly.

CONFLICT OF INTEREST

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REFERENCES

1 Greenberg RK, Lu Q, Roselli EE, Svensson LG, Moon MC, Hernandez AV, et al. Contemporary analysis of descending thoracic and thoracoabdominal aneurysm repair: a comparison of endovascular and open techniques. *Circulation* 2008;**118**: 808—17.

2 Etz CD, Kari FA, Mueller CS, Brenner RM, Lin HM, Griepp RB. The collateral network concept: remodeling of the arterial collateral network after experimental segmental artery sacrifice. *J Thorac Cardiovasc Surg* 2011;**141**:1029—36.

3 Etz CD, Kari FA, Mueller CS, Silovitz D, Brenner RM, Lin HM, et al. The collateral network concept: a reassessment of the anatomy of spinal cord perfusion. *J Thorac Cardiovasc Surg* 2011;**141**:1020—8.

4 Amr G, Sobocinski J, Koussa M, El Arid JM, Nicolini P, Haulon S. Staged procedure to prevent major adverse events in extensive aortic aneurysm repair. *J Vasc Surg* 2013;**57**:1671—3.

5 Maurel B, Delclaux N, Sobocinski J, Hertault A, Martin-Gonzalez T, Moussa M, et al. The impact of early pelvic and lower limb reperfusion and attentive peri-operative management on the incidence of spinal cord ischemia during thoracoabdominal aortic aneurysm endovascular repair. *Eur J Vasc Endovasc Surg* 2015;**49**(3):248—54.

6 Buth J, Harris PL, Hobo R, van Eps R, Cuypers P, Duijm L, et al. Neurologic complications associated with endovascular repair of thoracic aortic pathology: incidence and risk factors. A study from the European collaborators on stent/graft techniques for aortic aneurysm repair (Eurostar) registry. *J Vasc Surg* 2007;**46**: 1103—10.

7 Czerny M, Eggebrecht H, Sodeck G, Verzini F, Cao P, Maritati G, et al. Mechanisms of symptomatic spinal cord ischemia after TEVAR: insights from the European registry of endovascular aortic repair complications (Eurec). *J Endovasc Ther* 2012;**19**: 37—43.

8 Khoynezhad A, Donayre CE, Bui H, Kopchok GE, Walot I, White RA. Risk factors of neurologic deficit after thoracic aortic endografting. *Ann Thorac Surg* 2007;**83**:S882—9.

9 Ullery BW, Cheung AT, Fairman RM, Jackson BM, Woo EY, Bavaria J, et al. Risk factors, outcomes, and clinical manifestations of spinal cord ischemia following thoracic endovascular aortic repair. *J Vasc Surg* 2011;**54**:677—84.

10 Canaud L, Karthikesalingam A, Jackson D, Cresswell L, Cliff M, Markar SS, et al. Clinical outcomes of single versus staged hybrid repair for thoracoabdominal aortic aneurysm. *J Vasc Surg* 2013;**58**:1192—200.