Parallel intercostal artery stenting and exclusion of symptomatic bucket-handle intercostal patch aneurysm

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ABSTRACT

Intercostal patch aneurysms after open thoracoabdominal aneurysm repair represent a challenging pathology, with highly variable patient anatomy and spinal cord ischemia risk. We present a case of a 51-year-old man with a large symptomatic "bucket-handle" loop graft intercostal patch aneurysm, which was treated with endovascular exclusion with concurrent parallel intercostal stent grafting. This case highlights specialized endovascular techniques to treat intercostal patch aneurysms and the necessity of meticulous operative case planning in both open and endovascular thoracoabdominal aneurysm repair. (J Vasc Surg Cases Innov Tech 2024;10:101486.)

Keywords: Intercostal patch; Intercostal patch aneurysm; Thoracoabdominal aneurysm

Intercostal artery incorporation by various techniques is an important aspect of spinal cord protection in open repair of thoracoabdominal aneurysms (TAAAs).[1] The incidence of intercostal patch aneurysms is rarely described; however, treatment is technically demanding.[2,3] Open redo thoracoabdominal approach can be morbid, and endovascular techniques are becoming more commonly utilized for the treatment of intercostal patch aneurysms.[3-7] Each case presents a unique challenge in aneurysm repair and prevention of spinal cord ischemia based on the individual patient's reconstructed anatomy as well as the subsequent risk of spinal cord ischemia. We present a case of a patient with a 7-cm intercostal patch aneurysms in a "bucket handle" configuration. The patient consented to publication of this case.

CASE REPORT

The patient is a 51-year-old male with a history of multiple aortic surgeries who presented urgently for evaluation of sudden back pain. The patient's history is significant for Type A aortic dissection nearly 15 years prior to presentation, for which he underwent ascending aortic replacement, as well as hypertension, chronic kidney disease, and a family history of intracranial aneurysms. Over the next 5 years, he had aneurysmal degeneration of his thoracoabdominal aorta to 7.1 cm, at which time he was referred to our institution. He underwent open repair of his Extent II, post-dissection TAAA under deep hypothermic circulatory arrest with debranching of the celiac and superior mesenteric arteries, reimplantation of the right renal artery as a Carrel patch, left nephrectomy for atrophic kidney with renovascular hypertension, and left internal iliac artery bypass, for preservation of pelvic and spinal cord perfusion. The T8-L1 intercostal arteries were incorporated as a Carrel patch to a 10 mm "bucket-handle" loop graft (Fig 1). Genetic testing was unable to be performed, and follow-up was sporadic due to insurance issues. Three years prior to presentation, the patient had widely patent grafts with no intercostal patch aneurysm. At the time of presentation, he experienced sudden onset back pain reminiscent of his previous dissection. A computed tomography angiogram (CTA) of the chest, abdomen, and pelvis was performed revealing widely patent aortic, iliac, and visceral grafts without stenosis or kinking. The bucket-handle patch had degenerated, now with a 7-cm intercostal patch aneurysm with several patent intercostal arteries with the largest measuring 4 mm (Fig 2). He was transferred to our institution where he was admitted for impulse control prior to intervention for his symptomatic intercostal patch aneurysm.

TECHNIQUE

The procedure was performed under minimal sedation and without cerebrospinal fluid drainage. Unilateral, percutaneous right femoral access was obtained, and the system was upsized to an 8F steerable sheath. Diagnostic angiogram confirmed aneurysmal degeneration of the intercostal patch and outlined the anatomy for treatment guidance. Two 22-mm Amplatzer Vascular Plugs II (Abbott Cardiovascular) were deployed in the proximal bucket-handle graft. Subsequent angiogram demonstrated several large lumbar arteries, corresponding to the CTA. Balloon occlusion of the distal bucket-handle was performed with a 14-mm angioplasty balloon under continuous, awake

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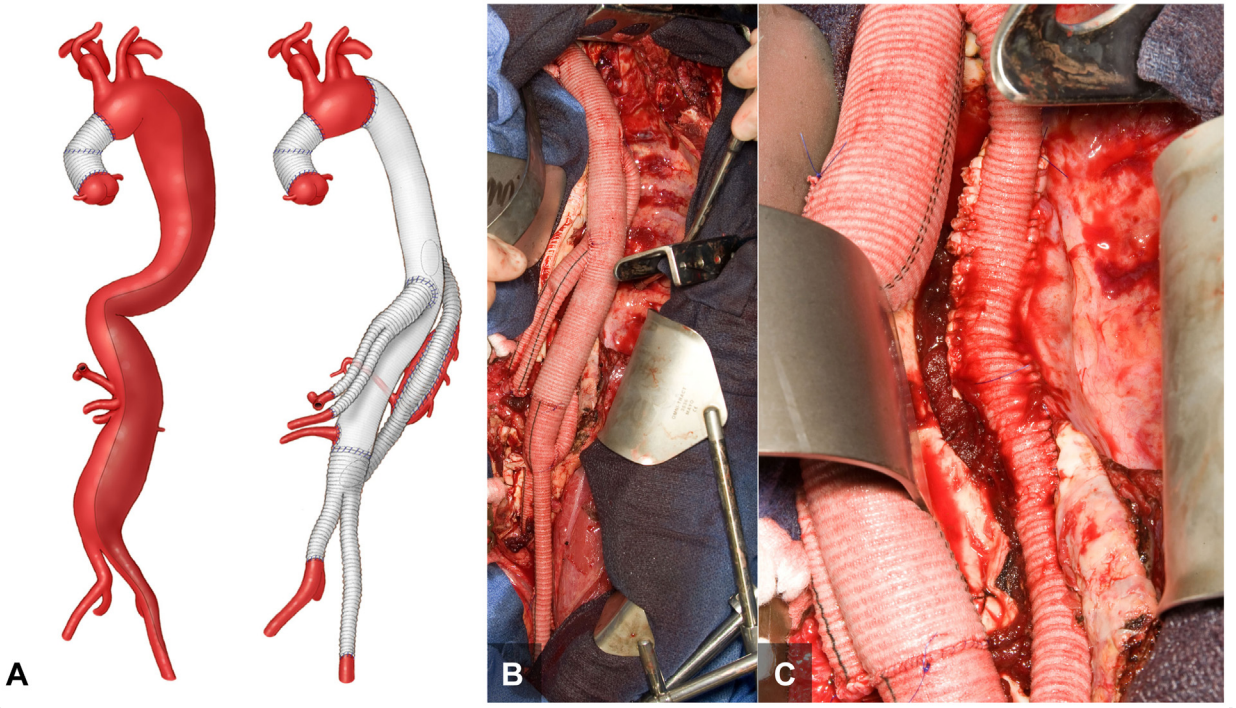

Fig 1. A, Artist representation of pre- and postoperative open thoracoabdominal repair. **B,** Operative reconstruction with debranching of celiac artery superior mesenteric artery, and reimplantation of right renal artery. **C,** Bucket-handle loop graft for intercostal patch.

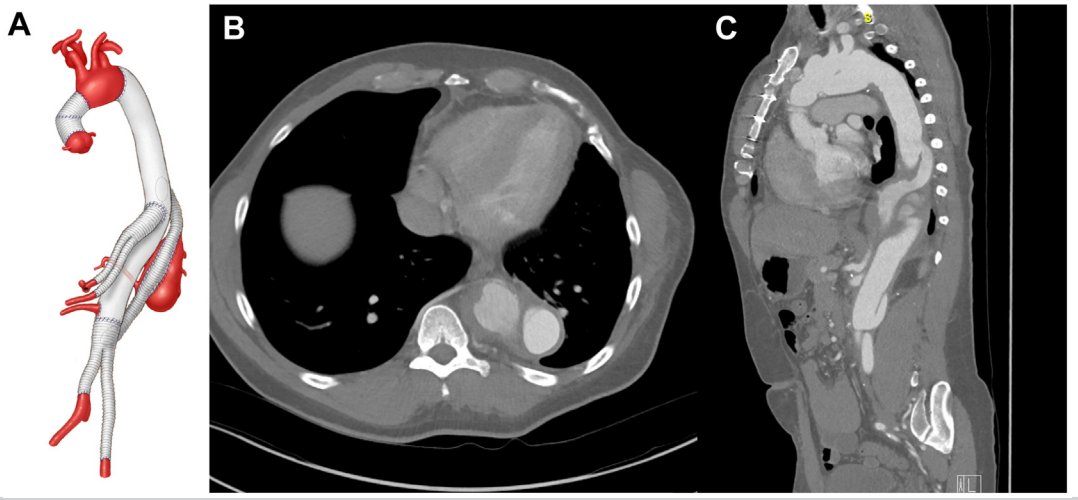

Fig 2. Preoperative computed tomography angiogram. **A,** Artist rendering of symptomatic intercostal patch aneurysm with patent intercostal arteries. **B,** Representative axial view demonstrating intercostal patch aneurysm with patent intercostal artery. **C,** Representative sagittal view demonstrating non-dilated proximal and distal bucket-handle Dacron graft.

neurologic monitoring for 20 minutes without mean arterial pressure augmentation (Fig 3, *A*). He had no motor changes; however, given the size of the lumbar arteries present, decision was made to cannulate the largest intercostal artery (Fig 3, *B*). A parallel stent in periscope configuration was deployed into the intercostal artery utilizing a 5 × 50 mm Viabahn stent graft (W.L. Gore & Associates) and was reinforced and extended distally with a 6 × 60 mm Innova bare metal stent (Boston Scientific Corporation). An 18- and a 22-mm Amplatzer Vascular Plug II were deployed into the distal bucket handle in periscope configuration

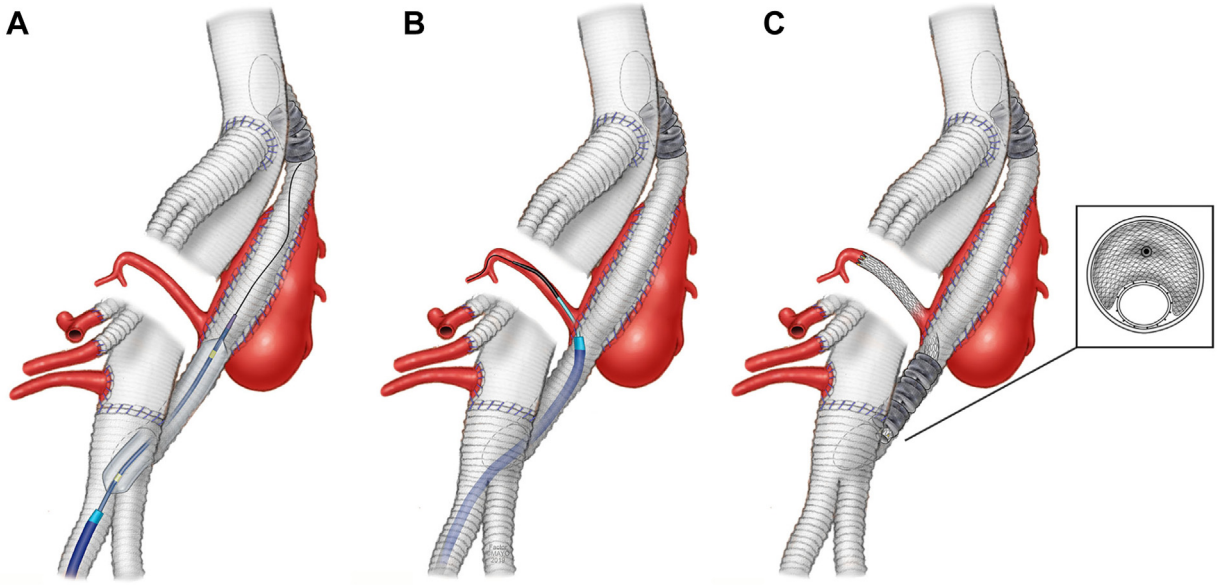

Fig 3. Artist depiction of the intraoperative course. **A,** Balloon occlusion testing of neurologic function in awake patient. **B,** Intercostal artery cannulation. **C,** Intercostal stent graft placement with proximal and distal plug. Inset: Parallel stenting along Amplatzer Plug.

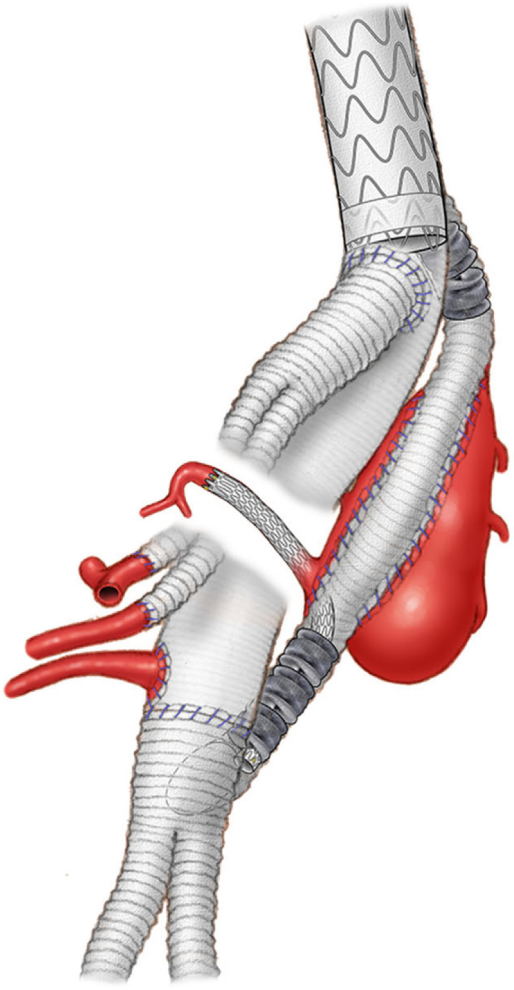

Fig 4. Artist rendering of completion repair after thoracic endovascular aneurysm repair (TEVAR).

with the stent graft (Fig 3, *C*, Inset). Completion angiogram and contrast enhanced cone-beam CT demonstrated patent intercostal stent, aortic grafts, and excluded patch aneurysm.

The patient did well postoperatively without neurologic deficit or complication. He was dismissed to home on second postoperative day, neurologically intact. Follow-up 8 months after the procedure showed antegrade endoleak around the proximal Amplatzer plug as well as type II endoleaks. The aneurysm sac had enlarged from 7 to 7.7 cm. He underwent thoracic endovascular aortic repair (TEVAR) to exclude the proximal bucket-handle with a Gore conformable C-Tag (W.L. Gore & Associates) (Fig 4). He was dismissed on postoperative day one after this procedure on clopidogrel and baby aspirin.

At 4-year follow-up after intercostal stent placement, the patient continues to do well without neurologic compromise and no further episodes of back pain. CTA performed at 4-year follow-up demonstrated widely patent aortoiliac and visceral debranching grafts with exclusion of the intercostal patch. The parallel stent to his intercostal artery is patent without stenosis. He continues to have a small, persistent Type II endoleak from the non-stented intercostal, with 4-mm total growth in 4 years since undergoing TEVAR (Fig 5). Given the non-significant growth over 4 years, the patient has undergone continued monitoring of the endoleak without plans for intervention unless he has substantial aneurysm sac growth. Socioeconomic and insurance issues still limit the ability to obtain genetic testing despite improved coverage for clinical follow-up at this time.

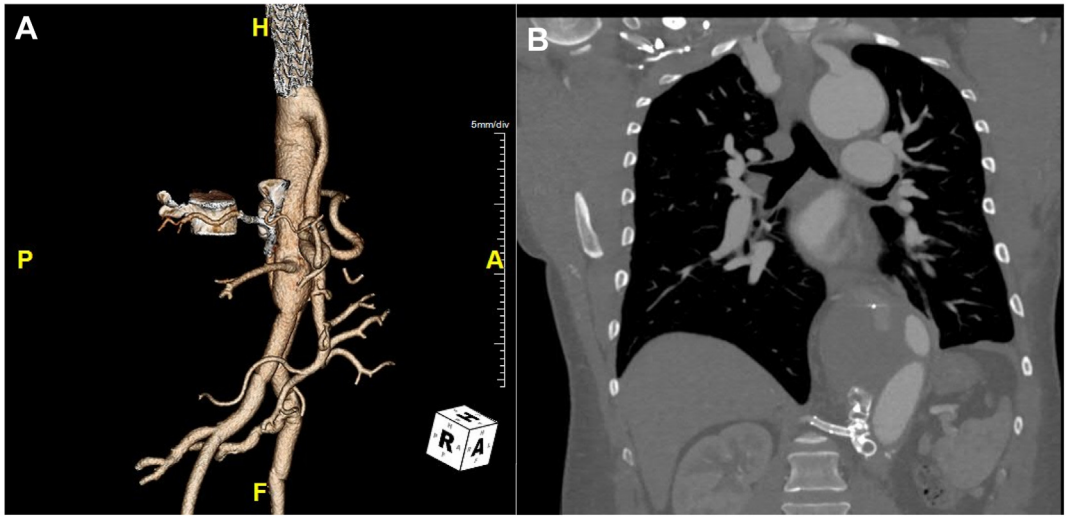

Fig 5. Postoperative computed tomography angiogram (CTA). **A,** Representative, inverted posterolateral view of 3D reformat demonstrating occluded excluded intercostal patch with patent intercostal artery stent at 4 years. **B,** Representative coronal view of the patent intercostal stent at the distal extent.

DISCUSSION

Although rarely reported, intercostal patch aneurysms are a late complication of open TAAA repair, particularly in those patients with connective tissue disorders.[2,4] Individualized spinal cord protection strategies need to be implemented during open thoracoabdominal aneurysm repair. Although a Carrell patch may predispose patients to late degeneration in this patient population, it does offer the advantage of preservation of multiple intercostal arteries for spinal cord protection. However, as seen in this case, use of a Carrell patch does require careful planning in the index operation to allow for late treatment of patch aneurysms by endovascular means. Endovascular salvage of open TAAA grafts for both intercostal and visceral patch aneurysms is a safe alternative to redo open TAAA repair, particularly in high-risk patients. Most techniques involve coverage of the intercostal arteries in their entirety with TEVAR or fenestrated-branched endovascular aortic repair after open TAAA with either custom-made or physician-modified devices.[3,5-12] Intercostal stenting is described during treatment of true intercostal aneurysms or pseudoaneurysms, often for rupture.[13-15] Intercostal preservation has also been demonstrated during index fenestrated-branched endovascular aortic repair with dedicated side stents or scallops.[16,17] Intercostal artery stenting is rarely utilized in intercostal artery preservation during treatment of intercostal patch aneurysms but is feasible, particularly when parallel grafting can be utilized as demonstrated in a similar case by Tjaden et al.[18] That case also demonstrates the importance of test balloon occlusion of the intercostals with continuous neurologic monitoring prior to finalizing the operative plan, as was done with our patient as well, to mitigate spinal cord ischemia risk. Additionally, the authors highlight alternative configurations with TEVAR with periscope techniques.[18] Given variable configurations of intercostal preservation, treatment will need to be individualized to the anatomy with considerations for endograft placement vs use of occlusion devices to avoid reinterventions as highlighted in our case. As smaller diameter stents become available with advancements in coronary and tibial disease treatments, intercostal incorporation may become a more common strategy in endovascular TAAA repair and intercostal patch aneurysm treatment. With current technologies, however, very specific patient anatomy and spinal cord injury risk dictates feasibility of treatment in this manner and meticulous planning is necessary for optimal outcomes. Given its rarity, it is very difficult to estimate patency rates for such small stent grafts.

CONCLUSION

We present an illustrative case of symptomatic bucket-handle intercostal patch aneurysm treated with exclusion and occlusion of the looped graft with parallel intercostal artery stenting for spinal cord protection. Intercostal stenting may be beneficial in select cases when anatomically feasible and can demonstrate mid-term patency. Treatment of intercostal patch aneurysms remains difficult and requires careful planning both late treatment and in index open thoracoabdominal repair to plan for successful subsequent interventions.

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