Hybrid repair of acute type B dissection with aberrant right subclavian artery and bicarotid trunk

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ABSTRACT

Patients with type B aortic dissection (TBAD) often present as an emergency. Operative repair of TBAD can be indicated for selected patients in the setting of hemodynamic instability or rupture. Thoracic endovascular aortic repair of TBAD has achieved significant popularity. Variant aortic arch anatomy can present a significant clinical challenge in patients with an inadequate proximal landing zone for thoracic endovascular aortic repair. A three-stage, hybrid aortic arch debranching and endovascular repair of a ruptured TBAD in a patient with a bicarotid trunk and an aberrant right subclavian artery was successfully performed using a unique technical approach. (J Vasc Surg Cases Innov Tech 2022;8:214-7.)

Keywords: Aortic arch debranching; Aortic arch replacement; Aortic dissection; Hybrid aortic arch repair; Thoracic endovascular aortic repair

Acute thoracic aortic dissection can be characterized by a wide range of clinical presentations, including acute pain, malperfusion syndrome, and shock. Type B aortic dissections (TBADs) originate in the thoracic aorta, distal to zone 0. Many patients can be stabilized with aggressive medical management. However, recent trials have suggested a benefit with ultimate thoracic endovascular aortic repair (TEVAR), in addition to the best medical therapy for aortic remodeling.[1] The surgical indications for acute TBAD include evidence of end-organ malperfusion, refractory pain, rapid false lumen expansion, and evidence of impending or active rupture.[1] TEVAR, compared with open surgical repair, has been associated with improved outcomes for patients with amenable landing zone anatomy.[2] Patients with atypical aortic arch branching patterns represent a unique challenge in that the proximal landing zone length required to achieve a seal across an intimal defect could be inadequate for satisfactory deployment of a TEVAR graft. Various surgical techniques have been described to create an additional proximal landing zone for stable placement of a TEVAR graft across the aortic arch.[3,4] In this report, we have described a three-staged approach to the management of this complex anatomy. The present patient has provided written informed consent for the report of his case details and imaging studies for teaching purposes.

CASE REPORT

A 47-year-old man with stage 3 chronic kidney disease and uncontrolled hypertension had presented to the emergency department with symptoms of back pain. A computed tomography angiogram (CTA) of the chest demonstrated an acute, contained rupture of a 7.9-cm TBAD with an obvious entry tear immediately distal to an aberrant right subclavian artery that originated at a Kommerell diverticulum (Fig 1). A detailed review of his CTA revealed a common bicarotid trunk with <2 mm of distance between each of the three arch branches (bicarotid, left subclavian, and aberrant right subclavian arteries). The aortic dissection demonstrated an interval expansion from 6.2 to 7.9 cm, compared with a surveillance CTA performed 6 months before his present admission. Evidence of acute rupture included new, high-density material present throughout the mediastinum. Open repair was discussed; however, his imaging findings appeared consistent with a contained rupture, and the patient was hemodynamically stable. He had had inconsistent outpatient follow-up, was known to have chronic renal insufficiency, was actively smoking, and had obstructive sleep apnea. In keeping with the established guidelines for the management of TBAD in patients with significant comorbid conditions, a multidisciplinary decision was made to proceed with staged endovascular repair. After review, he did not have an adequate landing zone to reliably seal the entry tear with a TEVAR-only approach. He, therefore, underwent three-stage hybrid repair, which was completed at three different operative sessions on three separate days.

The first stage involved right carotid artery to right subclavian artery bypass. The second stage involved aortic arch

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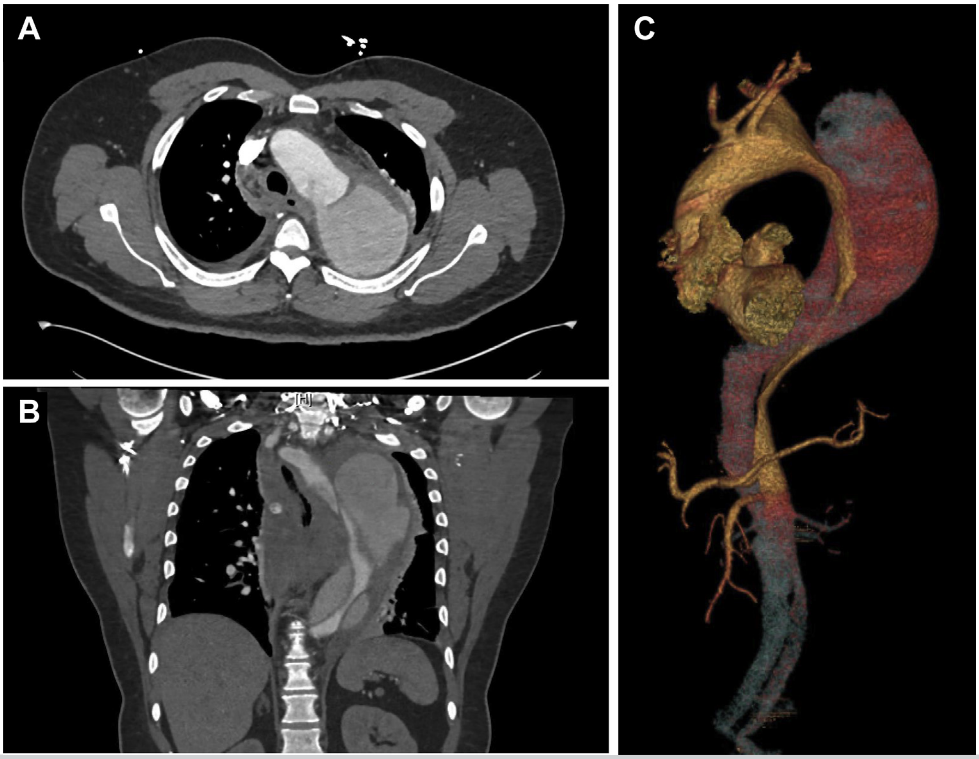

Fig 1. Preoperative computed tomography angiogram (CTA) demonstrating a 7.9-cm ruptured type B aortic dissection (TBAD). **A,** Axial configuration showing an intimal tear with contrast filling a large false lumen. **B,** Coronal configuration showing true lumen compression and increased soft tissue density in the mediastinum. **C,** Three-dimensional reconstruction showing variant arch branching anatomy, including a bicarotid arterial trunk, left subclavian artery, and an aberrant right subclavian artery.

debranching with cardiopulmonary bypass. This technique has been described in detail by Hughes.[5] In brief, the patient underwent central cannulation. Using an intermittent low-flow technique with mild systemic hypothermia (34°C), the left subclavian artery and the bicarotid trunk were sequentially clamped, debranched, and individually anastomosed in a staged fashion to a customized bifurcated graft sewn to the proximal ascending aorta at the level of the sinotubular junction using a partial clamp technique. During this procedure, continuous cerebral perfusion was maintained via retrograde flow through the recent right carotid–subclavian artery bypass conduit. This entire operation was performed under continuous electroencephalographic and cerebral oximetry monitoring. The third stage, the final stage, involved endovascular plugging of the native aberrant right subclavian artery using an Amplatzer occlusion device and subsequent retrograde TEVAR. TEVAR was performed via the left femoral artery with complete coverage of the aortic arch and the type B dissection entry tear. Gore conformable TAG thoracic endoprosthesis devices (W.L. Gore & Associates, Inc, Flagstaff, AZ) were placed in the aorta, extending from the ascending aorta just distal to the debranching graft anastomosis to the descending thoracic aorta, and stopping just proximal to the celiac axis. Postoperatively, no neurologic abnormalities were found. The patient required temporary renal replacement therapy but was ultimately discharged home. The immediate follow-up CTA on postoperative day 6 demonstrated a patent right carotid–subclavian artery bypass, a patent ascending aortic debranching graft, and satisfactory coverage of the TBAD without evidence of endoleak or flow into the aberrant right subclavian artery (Fig 2). A CTA at 12 months demonstrated no endoleak and a reduction in the size of the excluded aortic lumen at 5.5 cm compared with 7.5 cm previously. The patient had resumed his normal activities.

DISCUSSION

TEVAR has achieved significant popularity in the management of acute TBAD, with or without rupture, owing to the reduced physiological insult to a compromised patient and suspected reduction in the rates of paraplegia and death compared with traditional open surgical TBAD repair.[2] One common complication of TEVAR is endoleak. The current commercially available TEVAR device indications for use state the need for a landing zone of ≥2 cm to reliably achieve an occlusive seal (W.L. Gore & Associates). Off-label use has resulted in a satisfactory seal in patients with shorter landing zones; however, this increases the risk of type I endoleaks. For those patients with only millimeters of landing zone available,

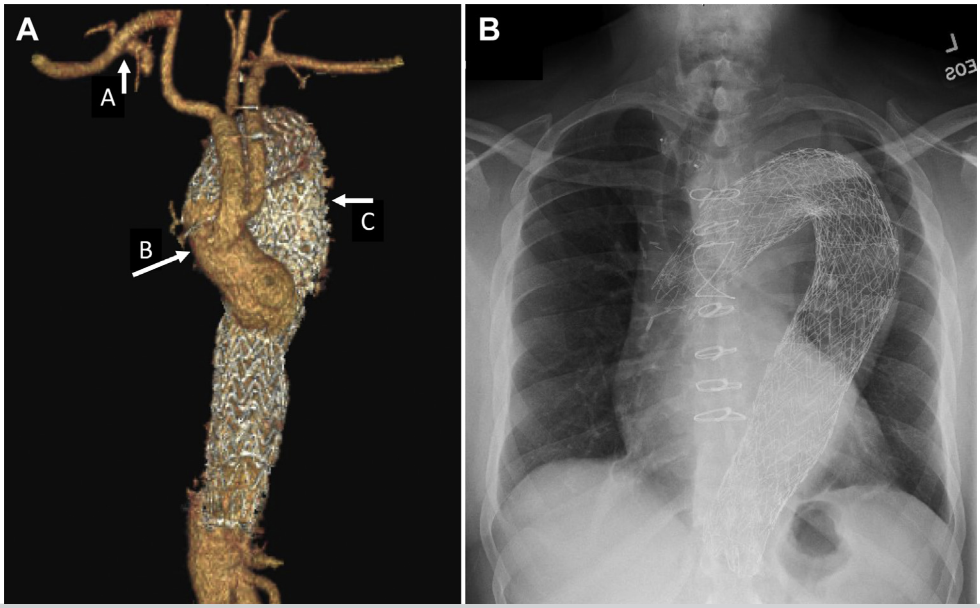

Fig 2. A, Postoperative computed tomography angiogram (CTA) demonstrating a patent right carotid artery to right subclavian artery bypass graft with interruption of the native aberrant right subclavian artery (*A*), a patent common bicarotid trunk and left subclavian artery debranching graft (*B*), and thoracic endovascular aortic repair (TEVAR) covering the aortic arch, aberrant right subclavian artery origin, and type B aortic dissection (TBAD) without evidence of endoleak (*C*). **B,** Upright chest radiograph demonstrating postoperative positioning of the TEVAR stent.

vascular debranching techniques can extend the length of the proximal landing zone.[3]

The most common aortic arch branching pattern involves three primary vessels, with the brachiocephalic trunk originating first, followed by the left common carotid artery, and, finally, the left subclavian artery.[6] Uncommon aortic arch branch patterns reported in thoracic surgical studies have included the presence of an aberrant right subclavian artery originating distal to the left subclavian artery (4%) and a bicarotid arterial trunk, in which both common carotid arteries originate from a common aortic trunk (17.8%). The incidence of the combination of these two variations has been ~2.3%.[7]

Aortic arch debranching requires detailed preoperative planning to prevent catastrophic neurologic complications. The critical elements of the techniques we have described and previously reported include the presence of continuous cerebral blood flow, objective confirmation of cerebral blood flow with neurologic monitoring before irreversible cerebrovascular flow interruption, moderate systemic hypothermia, reliable systemic perfusion via cardiopulmonary bypass, and meticulous anastomotic de-airing maneuvers.

Strategies for mitigating neurologic complications during TEVAR must also be discussed. First, we performed left subclavian arterial revascularization to augment spinal cord perfusion following TEVAR coverage. Second, we used intraoperative neurologic monitoring with motor evoked potentials and somatosensory evoked potentials acquisition to identify neurologic deficits occurring after TEVAR deployment. Third, during the immediate postoperative period, we maintained the systolic blood pressure between 120 and 160 mm Hg. Finally, the patient was extubated in the operating room after the TEVAR procedure, and an immediate neurologic assessment was performed. If a patient develops any deficits, the systolic blood pressure will be immediately augmented. If this maneuver does not resolve the deficits, a lumbar drain will be urgently placed. In the present patient, a lumbar drain was not used preemptively, in keeping with our institutional algorithm for the management of TBAD.

CONCLUSIONS

With modern thoracic and vascular imaging techniques, broad multidisciplinary expertise, and careful operative planning, complex aortic dissection in patients with variable anatomy can be safely managed. The principles and techniques used in the management of the present patient are translatable to patients with various branching abnormalities who might present with similar aortic pathology.

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