Emergent Treatment of Ruptured Kommerell's Diverticulum Using Bidirectional Endovascular Repair

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Abstract

We report an emergent complex hybrid repair of a type A Intramural Hematoma with a tear of the aortic arch at the site of Kommerell's Diverticulum and an Aberrant Right Subclavian Artery. We identified a type Ia endoleak intraoperatively, which was managed immediately with proximal extension. Performing this operation in the hybrid operating room facilitated optimal surgical management.

Introduction

Burckhard Friedrich Kommerell, in 1936, gave the first clinical description of Kommerell diverticulum (KD) and aberrant right subclavian artery (ARSA).[1] Embryologically, abnormal regression of the fourth right arch gives rise to the aberrant right subclavian artery. KD is believed to be a remnant of the primitive right dorsal aortic root. Prevalence of ARSA in the general population is around 0.5%-2.0%.

We report an emergent hybrid repair of ruptured kommerell's diverticulum with associated contained intramural hematoma (IMH) of the aortic arch (AoA), ascending aorta (AAo), and descending thoracic aorta (DTA) in the setting of the aortic arch and ascending aortic aneurysm.

Case Report

This is a 62-year-old African American male with hypertension who presented to the emergency department with acute onset tearing chest pain. Computed Tomography Angiography (CTA) demonstrated aneurysmal AAo, AoA, and DTA IMH with contained rupture of diverticulum of Kommerell with associated aberrant right subclavian artery.

The ARSA originated on the lesser curvature of the distal aortic arch, directly across from the left subclavian artery, and coursed posterior to the trachea and esophagus to supply the right arm (Figure 1). Because of the proximity of the diverticulum to the left subclavian (LSCA), its proximity to the left carotid takeoff, and the IMH extending across the AAo, AoA, and DTA, there was no adequate proximal landing zone for placement of an endograft. Thus, the operative plan was to perform right carotid subclavian bypass (dominant right vertebral artery), followed by open AAo zone II arch replacement with proximal intrathoracic ligation of ARSA and LSCA, open debranching of the bilateral carotid arteries, followed by a retrograde TEVAR.

Right carotid-subclavian artery bypass was done with 8 mm graft. A median sternotomy was performed. Cardiopulmonary bypass was initiated through central cannulation and cooling was initiated. Of note, the aortic root was not aneurysmal. A 32mm straight graft was sewn just above the sinotubular junction. Once the patient was adequately cooled, deep hypothermic circulatory arrest with ostial antegrade cerebral perfusion into both carotid arteries was initiated. The remainder of the ascending aorta and the entire arch was resected proximal to LSCA for zone II arch replacement. The ruptured Kommerell's diverticulum was

noted coming off the lesser curvature opposite the left subclavian artery. (Figure 2) The diverticulum was large, spanning 4 cm along the distal arch and proximal descending thoracic aorta. (Figure 2) The carotid arteries were first de-branched using a 14 mm bifurcated side branch. Attention was then turned back to the diverticulum and ARSA. Dissection was carried into the posterior mediastinum, deep to the trachea and esophagus, and its transition to the right subclavian artery was identified. We ligated the vessel at this point, and also proximally at the aortic takeoff using multiple 4-0 prolene pledgeted sutures. Arch replacement was then performed using a 32mm straight graft, along with ligation of the left subclavian artery. Then an antegrade TEVAR, using a 38x200mm Bolton Relay thoracic endograft, was performed to cover the tear site. A guidewire was passed into the descending thoracic aorta true lumen under both ultrasound and fluoroscopy guidance. The stent graft was then deployed, with the proximal landing zone within the 32mm straight graft. A graft-to-graft connection was performed to complete the operation.

Angiography demonstrated a type Ia endoleak, even though the endograft was landed into the aortic arch graft. Thus, we proceeded to perform retrograde TEVAR via a right femoral artery cutdown. A 42x115mm Bolon Relay thoracic stent graft was advanced into the AAo graft just distal to the carotid side branch and deployed. Completion angiography demonstrated no further filling of the aneurysm sac. A bronchoscopy was performed to confirm no injury to the trachea and intact vocal cord function. Completion angiography and imaging at 3 months showed intact repair without endoleak. (Figure 3)

Comment

Rupture at the site of KD has been previously reported in the literature. Austin et al., reported 19% incidence of rupture at the site of KD with 100% mortality.[2]

Surgical approach in a patient with aortic tear/rupture or acute dissection is centered on excluding the site of tear/rupture from the circulation to prevent exsanguination.

Open repair for type A IMH and proximal DTA rupture requires median sternotomy and AAo, total arch and proximal DTA replacement. Other option would be to do a two-stage procedure with total arch replacement and placement of an elephant trunk. However, two stage elephant trunk carries a significant interval mortality due to aortic cause, and also significant number of patients do not undergo second stage thoracotomy for completion.[3] Conventional elephant trunk also does not address the DTA rupture immediately.

The various options for hybrid repair in this setting include total arch replacement and elephant trunk placement followed by endovascular completion,[4] total arch replacement and placement of a frozen elephant trunk (FET),[4] subclavian artery bypass followed by zone 2 TEVAR and coil embolization of SCA,[4] or a single stage total aortic arch debranching and TEVAR with zone 0 landing.[5] Totally endovascular exclusion of ruptured KD with SCA stenting has also been demonstrated.[6]

Pathology of the AAo and AoA in our patient mandated AAo and arch replacement. Lack of landing zone between carotid and subclavian ostium and large size of the aortic arch precluded the option of retrograde TEVAR with zone 2 placement. We chose the option of FET as it can be safely deployed in this narrow area. Stent graft in DTA also provides a more stable landing zone for retrograde TEVAR compared to the standard elephant trunk.[7]

We ligated the origin of both the subclavian arteries as it has been shown to be the source of type II endoleak.[(4,8)]However, we had type Ia endoleak after completion of FET and this was remedied with more extensive zone 0 landing in the ascending aortic graft. Initial performance of subclavian-carotid bypass and carotid debranching gave us flexibility to better exclude the site of tear and fix type Ia endoleak with retrograde TEVAR.

Author Contributions:

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Figure Legends

Figure 1: CT Angiography (A) Axial section showing origin of aberrant right subclavian artery from the Kommerell's diverticulum at the level of origin of left subclavian artery. (B) Coronal section showing tear in the Komerrell's diverticulum and course of the aberrant right subclavian artery.

Figure 2: Intraoperative photograph showing wide tear in the distal aortic arch (site of the ruptured Kommerell's diverticulum).

Figure 3: (A) Completion Angiography after deployment of stents showing no leak and patent right carotid to subclavian bypass. (B,C) 3-month CT Angiography image: coronal and sagittal section respectively denoting an intact distal aortic arch and good re-modeling of descending thoracic aorta and distal arch.