CASE REPORT

Endovascular repair of a leaking aortic-arch pseudoaneurysm using graft stent combined with chimney protection to left common carotid artery: Case report and review of literature

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Aortic pseudoaneurysm (PsA) is a rare but serious condition that has high mortality and morbidity rates if untreated. We report a rare case of leaking aortic-arch PsA repaired by thoracic endovascular aortic repair using graft stent with the chimney technique to protect the left common carotid artery. Unlike other cases in the literature, our case was unique, having leaking PsA not related to previous cardiac surgery or aortic dissection. The successful management of this patient using thoracic endovascular aortic repair combined with the chimney technique suggests that this approach may be an attractive therapeutic alternative to treat aortic-arch PsA.

Keywords: Aortic-arch pseudoaneurysm, Thoracic endovascular aortic repair

Introduction

Pseudoaneurysm (PsA) is defined as a disruption of the inner and medial layers of the arterial wall with extravasation of blood into a delicate sac contained by adventitia and/or surrounding mediastinal structures [1]. Aortic PsA is a rare but serious complication of various types of cardiac surgery [2], trauma [3], aortic dissection, and infection [4]. Individuals with aortic PsA may remain asymptomatic for a period of months to

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years, and may be discovered accidentally. Some patients may experience variable symptoms ranging from mass effect on the surrounding structures to chest pain [5]. Untreated aortic PsAs are associated with high mortality (up to 60%) and morbidity rates, owing to their tendency to expand and rupture, and their tendency to be a source of infection and distal embolization [6,7]. Consequently, immediate intervention is necessary to minimize the lethal complications associated with aortic PsAs. The traditional repair options are surgical ligation and grafting, although they have a high mortality rate (7–17%) [8]. In high-surgical-risk patients, there are alternative management options that may include minimally invasive percutaneous approaches using thoracic endovascular aortic repair (TEVAR) [9], coil embolization, and thrombin injection [10]. We report a rare case of leaking aortic-arch PsA repaired by TEVAR using graft stent with chimney technique to the left common carotid artery (LCCA).

Case report

An 85-year-old female, a known case of hypertension, was referred from a peripheral hospital as a case of retrosternal chest pain occurring over a period of 6 days for workup. Other systemic review was unremarkable. At admission, the patient was fully conscious with normal cognition. Her vital signs were relatively stable with a heart rate of 98 beats per minute, blood pressure of 98/47 mmHg, and a respiratory rate of 26 breaths per minute. She had decreased air entry in the upper lung zones bilaterally. Other than a hemoglobin of 6.8 gm/dl, her initial laboratory findings were normal. She received a packed red-blood-cell transfusion during admission.

A chest X-ray showed widening of the mediastinum and left-upper-zone heterogeneous opacity (Fig. 1A). Baseline electrocardiography was unremarkable. Echocardiography revealed significant septal left ventricular hypertrophy with normal systolic function (ejection fraction = 55%)

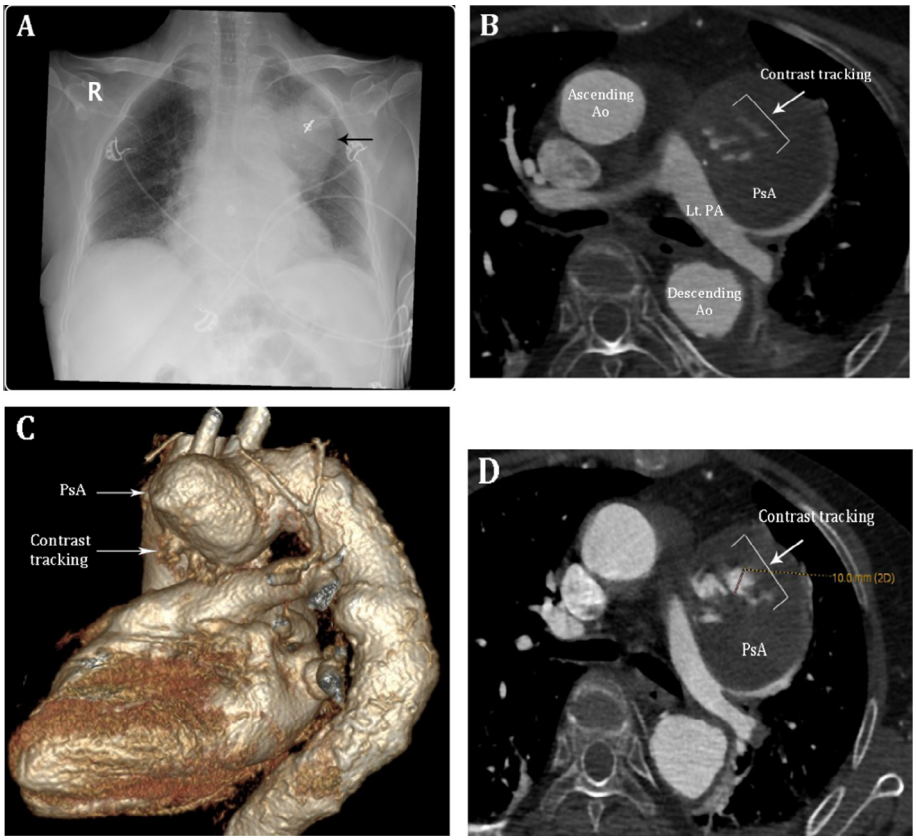

Figure 1. Preoperative chest X-ray and CTA: (A) chest X-ray showing widening of the mediastinum with left upper zone opacity (arrow); (B) and (C) initial CTA demonstrated saccular aortic-arch PsA with contrast tracking; (D) repeated CTA showing a minimal to mild interval increase in PsA size and contrast tracking. Ao = aorta; CTA = computed tomography aortogram; Lt. PA = left pulmonary artery; PsA = pseudoaneurysm.

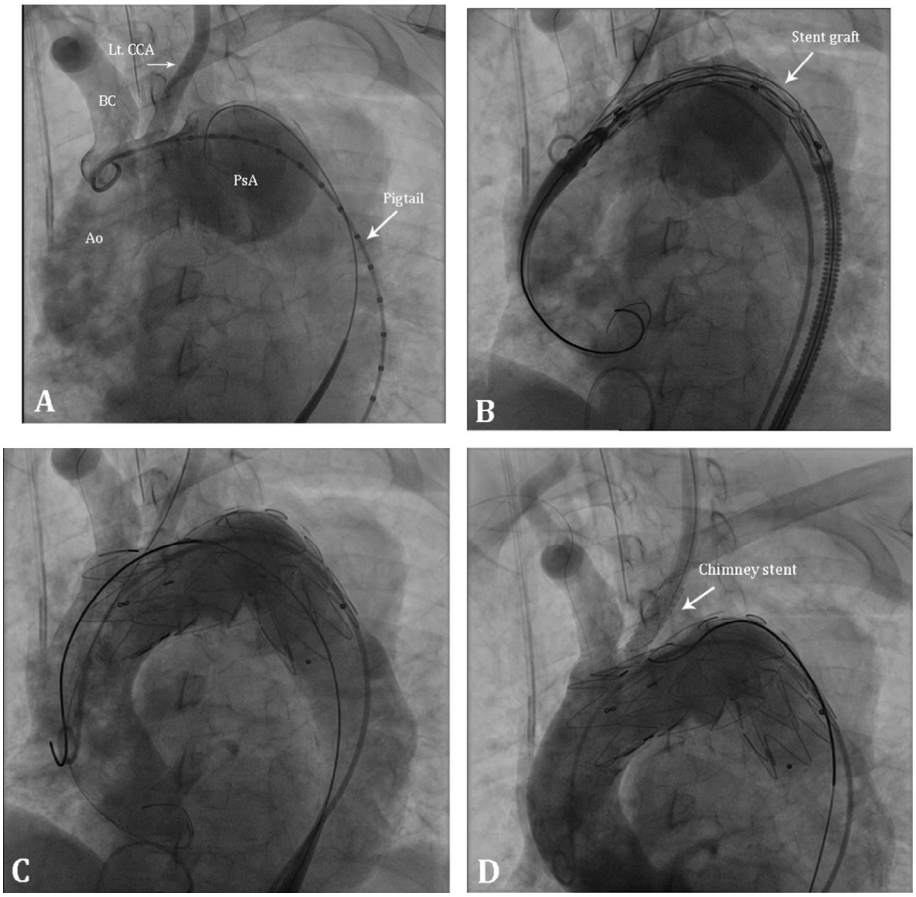

Figure 2. Thoracic angiography: (A) showing a PsA was evident at the proximal descending aorta arising at the level of the left subclavian artery from the left lateral aspect of the aortic arch; (B) and (C) stent-graft deployment with near-total coverage of the LCCA and the left subclavian artery; (D) retrograde chimney stenting to the LCCA through transcarotid approach; no evidence of endoleak and patent LCCA. Ao = aorta; BC = brachiocephalic; LCCA = left common carotid artery; Lt. CCA = left common carotid; PsA = pseudoaneurysm.

and without left ventricular obstruction, mild left ventricular diastolic dysfunction, and ascending aorta of average size (30 mm) with calcified walls. Carotid duplex revealed atherosclerotic changes with multiple hemodynamically insignificant stenosis and a focal dilatation of the origin of the left internal carotid artery measuring 12 mm × 7. 5 mm.

An initial computed tomography aortogram (CTA) confirmed the diagnosis of thoracic aorta saccular PsA at the proximal descending aorta arising at the level of the left subclavian artery from the left lateral aspect of the aortic arch, and surrounded by hypodense contained collection (about 30 mm in diameter) and another extension overlying the posterior superior aspect of the pericardium (measuring about 26 mm × 24 mm × 31 mm). The maximum diameter of the whole PsA was 77 mm × 67.5 mm × 56.8 mm, and there was mild periaortic-fluid density (10 mm in thickness) proximal to the origin of the brachiocephalic (BC) artery. One week later, a repeated CTA demonstrated an interval worsening of the patient's condition, and there was mild increase in the size of the aortic-arch PsA, measuring 78. 3 mm × 69.3 mm × 56 mm, and a mild increase in the periaortic-fluid density measuring about 13 mm in thickness (Fig. 1B–D).

After discussion and evaluation by a heart team comprising cardiac surgeons, interventional cardiologists, and vascular surgeons, the patient was refused by vascular surgeons due to a high-risk profile. Therefore, the decision for TEVAR was made.

The procedure was performed under general anesthesia with a surgical team on standby. The right common femoral artery (CFA) was chosen as the main access; the left femoral artery was used for control aortography through a pigtail catheter that revealed a dilated arch; and the descending aortic PsA begins after the distal margin of the BC artery, and including the ostia of the LCCA and the subclavian artery. The left-femoral-vein access was used for the transvenous

pacemaker. Peripheral angiography showed that both CFAs were less than 6 mm in size and were challenging for percutaneous access. Then, a Valiant Thoracic Stent Graft with Captivia delivery system (36/100) was delivered smoothly on two Back-Up Meier wires (0.035 in × 300 cm) through the right femoral artery and positioned well distal to the BC artery down to the distal end of the PsA. The chimney technique was accomplished via an Advanta V12 (Atrium) (8 mm × 38 mm × 80 cm) stent, which was placed appropriately at the ostium of the LCCA to preserve its perfusion. At the end of the procedure, control aortography confirmed the proper positioning of the stent without evidence of a detectable leak, and patented both the BC artery and the LCCA. The right CFA was closed using two Perclose ProGlide 6F devices (Fig. 2).

After a total hospital stay of 4 days, the patient made a good recovery and was discharged home in a favorable condition. One month later, a follow-up CTA revealed successful aortic-arch PsA exclusion with patent LCCA chimney stent, and no significant endoleak was detected (Fig. 3).

Discussion

Aortic PsA is an uncommon but fatal condition that may complicate some cardiothoracic surgeries, including coronary-artery bypass grafting, cardiac valve surgery, and aortic-dissection repair. Aortic PsA has unpredictable consequences with 30–45% risk of rupture [2,11]. When the PsA involved the aortic arch, it becomes difficult and troublesome to manage due to its tortuosity, limited length, high blood flow, and proximity to the vital supra-aortic branches. Therefore, surgical management was the conventional method of repair, but it has high morbidity and mortality rates especially in high-risk patients [8]. As an alternative, Dake et al. [12] reported in 1994 the first minimally invasive percutaneous closure for thoracic aortic pathologies. The study included 13 patients, all of them were successfully treated with Dacron-covered self-expanding stainless-steel stent grafts. None of these 13 patients had died, or had neurological deficits, stroke, distal embolization, or infection [12]. Since then, the minimally invasive approach has had a great technical development. The encouraging advantages of this procedure are reducing the need for general anesthesia and many dangerous complications, including hemorrhage and visceral ischemia [13,14].

A number of minimally invasive procedures have been employed to manage aortic-arch lesions taking into considerations the supra-aortic vessels. There are basically two main approaches: hybrid and total TEVAR. The hybrid procedure can be described as a combination of extra-anatomic bypass of supra-aortic vessels with endovascular stent-graft deployment. In 1999, Quiñones-Baldrich et al. [15] introduced a case of type IV thoraco-abdominal aneurysm treated with conventional open surgery for retrograde perfusion of visceral vessels combined with endovascular stent grafting. The aim of this technique is to eliminate cardiopulmonary bypass and hypothermic circulatory arrest. Although effective, the hybrid procedure has considerable morbidity and mortality rates. Kang et al. [16] conducted a retrospective analysis of 20 patients who underwent hybrid aortic-arch repair. They reported morbidity and mortality rates of 28.6% and

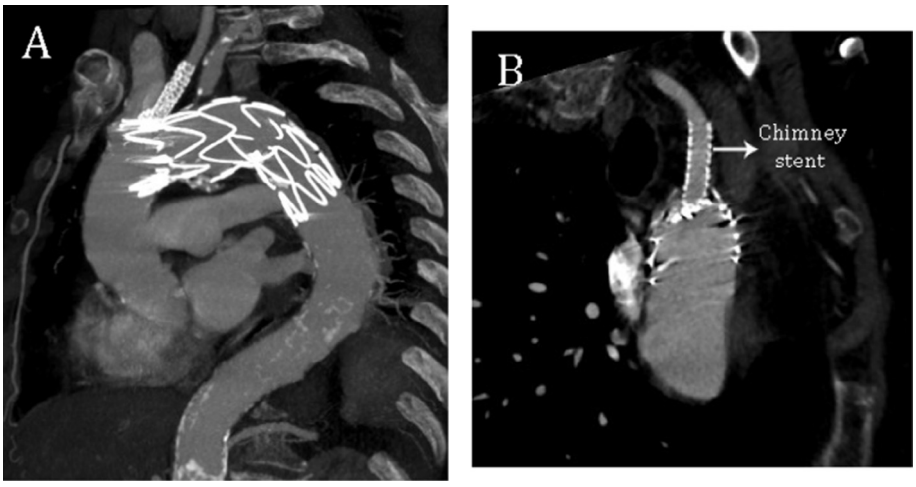

Figure 3. Postoperative CTA: (A) and (B) confirm the excellent exclusion of the aortic-arch PsA, no significant endoleak, and the patency of both aorta and LCCA. CTA = computed tomography aortogram; LCCA = left common carotid artery; PsA = pseudoaneurysm.

14.3%, respectively. The weakest point of the hybrid repair is its high rate of endoleak development, especially type Ia, which was reported to be as high as 14.3% [16].

TEVAR for aortic arch can be accomplished by fenestrated/branched stent graft or chimney technique in order to maintain blood flow to the vital organs. Fenestrated TEVAR is the delivery of a stent graft with fenestrations, which directed precisely to the target vessels [17]. A study was carried out by Kurimoto et al. [18] from 2007 through 2013 to identify the clinical outcomes of fenestrated TEVAR performed on 37 patients with aortic-arch disease. The main outcomes were stroke and type Ia endoleaks, which developed in 8% and 32% of the patients, respectively [18]. Branched TEVAR is used mainly when a fenestrated stent graft fails to appose the target vessels properly. Haulon et al. [19] in 2014 performed a retrospective multicenter study for 38 patients with aortic-arch aneurysm repaired by a branch stent graft; the 30-day mortality rate was 13% and early cerebrovascular deficits were diagnosed in 16% of cases [19].

Our patient presented with a chief complaint of retrosternal chest pain with no history of previous thoracic surgeries. The CTA was sufficient for the diagnosis of aortic PsA arising at the level of the left subclavian artery from the left lateral aspect of the aortic arch. In our case, TEVAR was the most convenient method of repair because the patient was surgically prohibited due to her lean body weight and advanced age. However, the main technical challenge in this complex case was the critical position of the PsA; thus, the straightforward performance of TEVAR with a covered graft stent may result in cerebral ischemia and infarction. Because of this, we aimed to apply the chimney-graft technique to the LCCA.

Chimney graft is defined as a covered or bare stent graft that is deployed parallel to the main aortic graft stent to protect the perfusion of vital side branches [20]. It was first identified by Greenberg et al. [21], who used it to preserve the renal-artery blood flow. Yang et al. [22] in 2012 conducted a systemic review to determine the safety and efficacy of the endovascular chimney technique for the preservation of supra-aortic-branch blood flow. A total of eight articles with 51 patients who underwent TEVAR with the chimney technique from 1994 to 2011 were enrolled in the study. They concluded that the chimney-graft technique for aortic-arch pathologies is technically applicable in both elective and emergency situations, and is associated with favorable perioperative outcomes with a success rate of 90.2% [22].

Unlike the previous case series, our case was unique as having leaking PsA not related to the previous cardiac surgery or aortic dissection. Our successful management for this patient using TEVAR combined with the chimney-graft technique suggests that this approach may be an attractive therapeutic alternative to treat aortic-arch PsA. A long-term follow-up is needed on a larger number of cases to approve these excellent outcomes in order to advocate the feasibility and applicability of this technique.

Conflicts of interest

The authors declare no conflict of interest.

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