

# Urgent Frozen Elephant Trunk for an Aortic Arch Pseudoaneurysm Secondary to Fractured Sternal Wire

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## Abstract

Pseudoaneurysms of the aorta are rare complications of cardiac surgery, and sternal re-entry to address the pathology is particularly challenging. In this case, we describe a rare presentation of thoracic aortic pseudoaneurysm due to chronic erosion from a sternal wire, 10 years following the index operation. The patient was treated in two-stages, including carotid-subclavian bypass, followed by sternal re-entry with total arch replacement and frozen elephant trunk, employing cardiopulmonary bypass via femoral and axillary cannulation. Despite the high risks of rupture/haemorrhage associated with sternal re-entry, operative success for aortic pseudoaneurysms can be achieved with careful planning and safe bypass strategies.

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### Rare complication post-dissection repair

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## Abstract

Pseudoaneurysms of the aorta are rare complications of cardiac surgery, and sternal re-entry to address the pathology is particularly challenging. In this case, we describe a rare presentation of thoracic aortic pseudoaneurysm due to chronic erosion from a sternal wire, 10 years following the index operation. The patient was treated in two-stages, including carotid-subclavian bypass, followed by sternal re-entry with total arch replacement and frozen elephant trunk, employing cardiopulmonary bypass via femoral and axillary cannulation. Despite the high risks of rupture/haemorrhage associated with sternal re-entry, operative success for aortic pseudoaneurysms can be achieved with careful planning and safe bypass strategies.

## Case presentation

A 68-year-old male hypertensive patient presented to the emergency department with acute anterior chest pain and voice hoarseness of recent onset. His past medical history was remarkable for an emergency operation 10 years ago for an acute type A aortic dissection which involved an ascending aorta replacement with a tube graft.

Computed tomography angiography (CTA) revealed a chronic dissecting aneurysm originating from the distal anastomosis of the previous 32 mm Dacron graft and extending to the celiac trunk. Maximum diameter was 10 cm for the descending thoracic aorta at the level of T7 (Figure 1).

Additionally, there was a pseudoaneurysm (3 x 5 cm) in the proximal aortic arch adjacent to the innominate artery (IA) origin penetrated by a fractured sternal wire (Figure 1C, D). The aortic arch branches were not dissected, and all abdominal aortic branches were perfused from the true lumen. Preoperative evaluation included coronary angiography and transthoracic echocardiography (TTE) which were unremarkable.

A two-stage urgent operation was planned which initially included a left carotid to left subclavian artery (LSA) bypass with interposition of 8 mm Dacron graft. The next morning the patient was transferred to the operating room for the definitive operation. To achieve optimal perfusion monitoring, three arterial lines (bi-radial, left femoral) were placed, and continuous cerebral monitoring by means of transcutaneous cerebral oximetry (INVOS 5100C Medtronic, MN, USA) was used. Cardiopulmonary bypass (CPB) was instituted via arterial cannulation of the right axillary artery through an 8 mm Dacron graft along with right femoral vein using a long venous cannula. A repeat median sternotomy was performed, and systemic cooling was started at 26°C. A left ventricular (vent) catheter was inserted through the right superior pulmonary vein. During cooling, careful dissection of the previous Dacron graft and both the innominate and left common carotid arteries (LCCA) was performed, carefully avoiding the area of the pseudoaneurysm. The innominate vein was ligated and divided for better exposure of the aortic arch branches. Antegrade cold crystalloid cardioplegia (Custodiol 25ml/kg) was administered after cross clamping the ascending aorta on the previous Dacron graft. Once the target bladder temperature of 26°C was reached, CPB was arrested. The distal ascending aorta and aortic arch just proximal to the origin of the LSA (zone 2) were excised. An island with the origins of IA and LCCA was created while the origin of LSA was ligated. Unilateral selective antegrade cerebral perfusion (SACP) was initiated through the right axillary artery after snaring the IA and LCCA. A soft guide wire inside a foley catheter was introduced in the true lumen of the descending thoracic aneurysm. The soft guide wire was then exchanged with a stiff wire, and the foley catheter was removed. The hybrid stent – graft system (28 x 150 mm E-vita open plus, Jotec Inc.) was introduced in an antegrade fashion through the open aortic arch in the descending thoracic aorta over the stiff guide wire and released with a pull–back system. The cuff of the hybrid prosthesis was anastomosed to the distal aortic stump with 3.0 polypropylene suture and externally reinforced with a Teflon strip. The Dacron free graft of the hybrid prosthesis was pulled back and the foley catheter was introduced in the descending aorta and used for lower body perfusion. The IA and LCCA were implanted into the Dacron graft using the island technique. Systemic rewarming was initiated and the final Dacron to Dacron anastomosis performed. CPB



was terminated with minimal inotropic support. Total CPB time was 220 min with 125 min ischaemia time, 15 min circulatory arrest, 65 min lower body arrest, and 105 min of selective antegrade cerebral perfusion. The patient's post-operative course was uneventful.

A month after discharge, the patient was admitted for additional thoracic endovascular aortic repair (TEVAR) down to the celiac trunk origin with complete remodelling of the dissected aorta (Figure 2D).

## Discussion

Pseudoaneurysms of the thoracic aorta have been reported as a rare but life-threatening complication of aortic surgery, infection, or trauma. In the case of post-operative cardiac patients, the literature suggests that hypertension, infection, previous aortic operation, and graft wrapping are risk factors for their occurrence(1,2). Even in high-risk aortic dissection patients, there is a low incidence of pseudoaneurysms arising(1).

The first report of chronic sternal wire erosion into the ascending aorta was in 1994, 9 years following coronary artery bypass(3). To our knowledge, the only other case of chronic sternal wire erosion of the ascending thoracic aorta following repair of aortic dissection was published in 2003(4). Other reports of sternal wire migration to the pulmonary artery(5) and right ventricle(6) have also been described.

There have been descriptions of sternal re-entry to address aortic pseudoaneurysms without the use of CPB or circulatory arrest(7). However, data from large series indicate that, for optimum long-term results, extra-mediastinal cannulation offer a safer and more versatile approach, particularly for large pseudoaneurysms(1). Other series have reported bilateral cannulation of both carotid arteries through limited cervicotomies for brain protection, as well as femoral cannulation for the institution of CPB(8). Our case has described the use of a two-stage procedure, including extra-anatomical carotid-to-subclavian bypass to enhance brain protection and augment CPB strategies.

## Ethics Statement

This manuscript and all of its content meet the ethical guidelines and obtained an ethical waiver from the study institution. Written consent for submission and publication of this case report including images and associated text has been obtained from the patient.

## References

1. Villavicencio MA, Orszulak TA, Sundt TM, Daly RC, Dearani JA, McGregor CGA, et al. Thoracic Aorta False Aneurysm: What Surgical Strategy Should Be Recommended? *Ann Thorac Surg*. 2006;82(1):81–9.
2. Katsumata T, Moorjani N, Vaccari G, Westaby S. Mediastinal false aneurysm after thoracic aortic surgery. *Ann Thorac Surg*. 2000;70(2):547–52.
3. Hazelrigg SR, Staller B. Migration of sternal wire into ascending aorta. *Ann Thorac Surg* [Internet]. 1994;57(4):1023–4.
4. Kao C, Chang J. Fracture of Sternal Wires. 2003;30(3):240–2.
5. Mokhtar AT, Baghaffar A, Ramer SA, Fraser JD. Migrated fractured sternal wire in proximity to the main pulmonary artery: Case report and review. *J Card Surg*. 2020;35(3):692–
6. Levisman J, Shemin RJ, Robertson JM, Pelikan P, Karlsberg RP. Migrated sternal wire into the right ventricle: Case report in cardiothoracic surgery. *J Card Surg*. 2010;25(2):161–2.
7. Black A, Alexander JA, Reoma J, Caranasos T, Staples ED, Martin TD, et al. Safe sternal reentry in patients with large thoracic aortic pseudoaneurysms. *Ann Thorac Surg*. 2014;97(2):705–7.
8. Bachet J, Pirotte M, Laborde F, Guilmet D. Reoperation for Giant False Aneurysm of the Thoracic Aorta: How to Reenter the Chest? *Ann Thorac Surg*. 2007;83(5):1610–4.

## Figure legends

**Figure 1:** (A,B) CTA, axial views of the proximal arch, pseudoaneurysm and chronic dissecting aneurysm with a maximum dilation (10 cm) at the level of the pulmonary artery bifurcation. (C,D) CTA, sagittal and



volume rendering views depicting the fractured sternal wire creating the proximal arche pseudoaneurysm.

**Figure 2:** Post-FET CTA axial (A) and volume rendering (B) showing complete thrombosis of the distal thoracic aorta, excellent deployment of the hybrid prosthesis and a patent LCCA to LSA bypass. Post-TEVAR CTA axial (C) and volume rendering (D) images showing thrombosis and complete remodelling of the aorta down to the origin of the celiac trunk.





