ARYA Atherosclerosis J

Case Report Open Access

Localized dissection of ascending aorta and arch rupture due to fire suppressant blast: A rare mechanism of injury successfully managed by urgent surgical intervention

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Received: 2025-02-19
Accepted: 2025-04-16

How to cite this article:
Grant R, Iyer A, Nezafati P. **Localized dissection of ascending aorta and arch rupture due to fire suppressant blast: A rare mechanism of injury successfully managed by urgent surgical intervention.** ARYA Atheroscler. 2025; 21(3): 1-4.

DOI:
http://dx.doi.org/10.48305/arya.2025.43477.3029

Abstract

BACKGROUND: Traumatic aortic injuries are predominantly caused by high-impact motor vehicle collisions, often due to sudden deceleration. This report presents a rare case of localized dissection and partial aortic arch rupture resulting from a fire suppressant explosion.

Case Presentation: A 36-year-old male was transferred following a fire suppressant explosion at a copper smelter. He presented with central chest pain and stable hemodynamics, with no signs of external chest trauma. Computed tomography (CT) imaging revealed a localized dissection of the ascending aorta and a partial rupture of the aortic arch, in addition to fractures in the hand and foot caused by suppressant debris. The patient subsequently became hemodynamically unstable and required urgent surgical intervention. He underwent ascending aortic and aortic arch repairs. Postoperatively, his course was complicated by a pulmonary embolism, which was managed medically. He was eventually discharged after recovering from his injuries.

CONCLUSION: Aortic injuries resulting from small-scale blasts can occur. Successful management relies on a high index of suspicion and timely surgical intervention.

Keywords: Aortic Dissection; Arch; Fire Blast; Trauma; Surgery

Introduction

Blunt thoracic trauma is a leading cause of mortality among individuals aged 5 to 40 years in developed nations[1]. Blunt traumatic aortic dissection (BTAD) is most frequently associated with motor vehicle accidents, typically due to rapid deceleration forces[2]. Other reported causes include pedestrian-vehicle collisions, falls from significant heights, and crush injuries[3]. BTAD is a severe injury with a notably high mortality rate, especially at the scene of the incident. Approximately 80% of patients with BTAD die before reaching the hospital[4]. Without prompt recognition and intervention, mortality rates can reach as high as 90%[5].

Aortic injuries in the form of localized dissection and partial arch rupture secondary to a fire suppressant explosion, without external trauma or deceleration, have not been previously reported. We present such a case.

Case Study

A 36-year-old male with no past medical history was transferred from a peripheral hospital after being exposed to a fire suppressant explosion while uninstalling a redundant suppression system from a crane at a copper smelter. He experienced a brief loss of consciousness at the scene, with reports of falling suppressant debris, but had no recollection of trauma to the head or chest, making the mechanism of injury unclear. Upon admission, he complained of central chest pain, as well as pain in the right ankle and left hand. He was alert, with a Glasgow Coma Scale (GCS) score of 15, and was initially hemodynamically stable. There was no external evidence of thoracic trauma, including bruising, hemorrhage, or burns. CT imaging of the chest revealed a localized dissection of the ascending aorta (Figure 1) and a partial rupture of the aortic arch, with blood tracking around the arch and descending thoracic aorta (Figure 2). Additionally, fractures of the dorsum of the left hand and the right foot were noted on X-rays, with no other traumatic pathology identified.

Following return from the CT scan, the patient exhibited hypotension and was immediately transferred to the operating theater. Intraoperative transesophageal

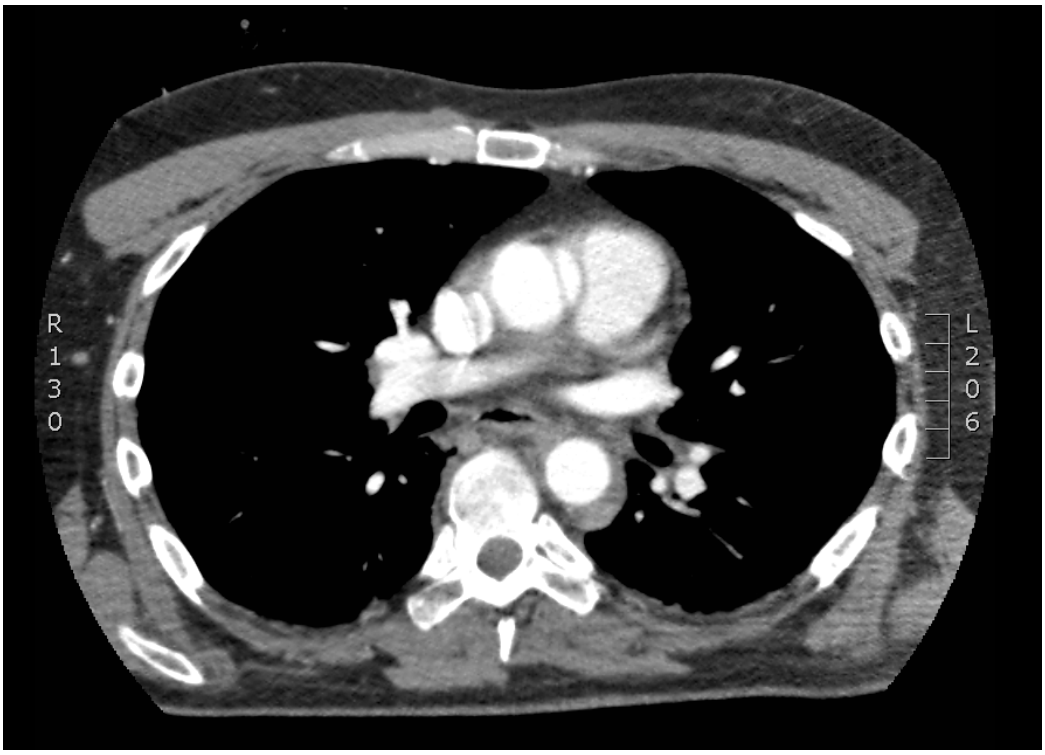

Figure 1. CT chest showing localized dissection involving ascending aorta

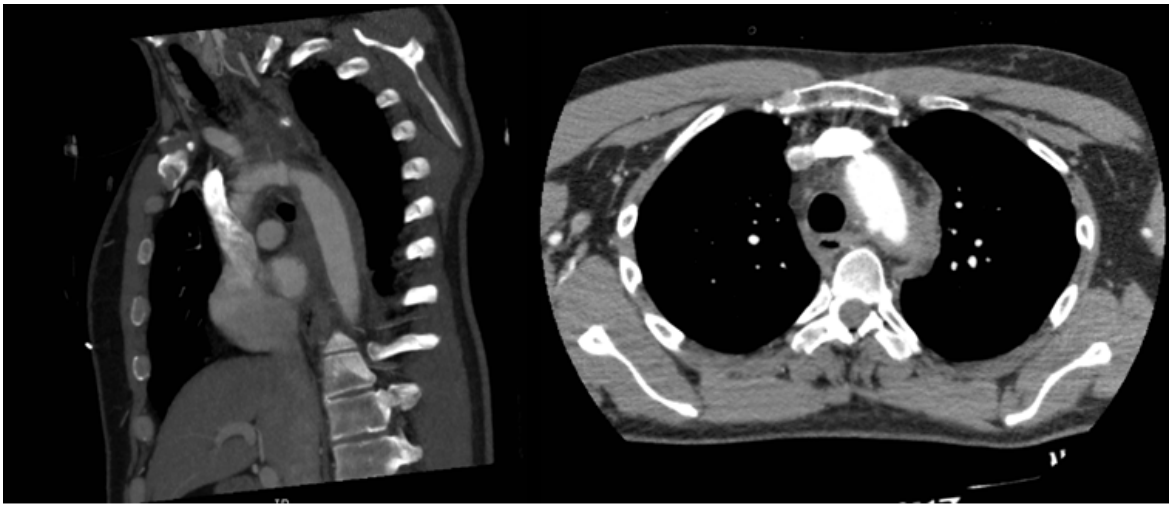

Figure 2. CT chest showing rupture of arch of aorta demonstrating extravasation of contrast and surround hemorrhage.

echocardiography (TEE) confirmed the CT findings. Cardiopulmonary bypass was initiated, and after cross-clamping, two small localized tears near the left coronary ostium were identified and repaired. Hypothermic circulatory arrest at 18°C was induced to facilitate aortic arch inspection, revealing a semicircular tear, which was repaired using bovine pericardium.

The patient recovered well postoperatively, with a complication of pulmonary embolism, which was managed medically. He was subsequently discharged in stable condition with good end-organ perfusion.

Discussion

The aortic isthmus, where the fixed descending aorta transitions into the more mobile aortic arch, is the most frequently affected site in BTAD due to its heightened susceptibility to strain during sudden deceleration[6]. However, other regions of the aorta may also be involved, including the ascending aorta (8–27%), aortic arch (8–18%), distal descending aorta (11–21%), and abdominal aorta[7,8].

For injuries involving the aortic isthmus and descending aorta, thoracic endovascular aortic repair (TEVAR) is an emerging alternative to open surgical repair. However, open surgical repair remains the standard of care in cases of ascending aortic or aortic arch injuries.

Cammack et al.[9] demonstrated that vertical deceleration and horizontal forces predominantly result in rupture of the ascending and descending aorta, respectively. In the present case, the subject was impacted by the fire suppressant explosion, with no signs of chest wall injury or bony fractures—hence, no evidence of vertical or horizontal force. It is plausible that the blast wave dynamics and their potential effects on vascular structures caused the BTAD. The exact mechanism of aortic dissection and rupture in the absence of direct external trauma or deceleration remains unclear. The blast wave dynamics and their vascular effects require further investigation to fully understand how such injuries occur.

Conclusion

Ascending aortic injuries due to small-scale blasts are exceptionally rare. This case involved a localized dissection of the ascending aorta with two tears near the left coronary ostium and a partial rupture of the aortic arch. Early recognition and prompt surgical intervention remain paramount to patient survival.

Conflict of interests

The authors declare no conflict of interest.

Funding

There is no funding in this study.

Author's Contributions

Study Conception or Design: RG; AI
Data Acquisition: RG; AI; PN
Data Analysis or Interpretation:
Manuscript Drafting: RG; PN
Critical Manuscript Revision: AI; PN
All authors have approved the final manuscript and are responsible for all aspects of the work.

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