



## Case report

# The diagnosis of delayed expanding traumatic pseudoaneurysm of thoracic aorta caused by self-inflicted penetrating injury with crossbow bolt: A case report

Shunsuke Nakamura<sup>a</sup>, Taihei Yamada<sup>b</sup>, Hiromichi Naito<sup>a,\*</sup>, Naoya Sakoda<sup>c</sup>, Atsunori Nakao<sup>a</sup>

<sup>a</sup> Department of Emergency, Critical Care and Disaster Medicine, Okayama University Graduate School of Medicine Dentistry and Pharmaceutical Sciences, Japan

<sup>b</sup> Department of Traumatology and Emergency Intensive Care Medicine, Okayama University Graduate School of Medicine Dentistry and Pharmaceutical Sciences, Japan

<sup>c</sup> Department of Cardiovascular Surgery, Okayama University Graduate School of Medicine Dentistry and Pharmaceutical Sciences, Japan

## ARTICLE INFO

## Keywords:

Case report  
Traumatic pseudoaneurysm  
Thoracic aortic injury  
Crossbow bolt  
Three-dimensional reconstruction  
Computed tomography

## ABSTRACT

**Introduction and importance:** Penetrating chest trauma caused by a crossbow bolt is very rare. Herein, we report a successfully treated patient who attempted suicide by directing a crossbow to the chest cavity and developed an expanding pseudoaneurysm of the thoracic aorta during eight-day follow up.

**Case presentation:** A 51-year-old male was admitted to the emergency department after firing a crossbow bolt twice into his left chest. At admission, the patient was hemodynamically stable and maintaining oxygenation. The bolt had already been removed from the body. Contrast-enhanced computed tomography (CT) revealed a cavity pseudoaneurysm 2.5 mm in size in the aortic arch. Three-dimensional reconstruction of the CT demonstrated wound tracts showing probable damage by the bolt. The patient was admitted to the emergency department for careful observation and transferred to the psychiatric ward on day two. Follow-up contrast-enhanced CT on day eight demonstrated rapid expansion of the pseudoaneurysm from 2.5 mm to 4.0 mm in size. We performed thoracic endovascular aortic repair (TEVAR) on day 13. The patient was uneventfully discharged on the 20th hospital day.

**Clinical discussion:** Emergency physicians should be aware that damage to the surrounding tissue may be accompanied by delayed expansion of an aortic pseudoaneurysm, even if the bolts do not cause direct aortic wall injury.

**Conclusion:** This case suggests that understanding the injury mechanism, confirming the tract of the bolts, and carefully exploring traumatic pseudoaneurysm can lead to a less invasive operation due to early detection.

## 1. Introduction

A crossbow is an easily accessible bow weapon used for hunting or sports that shoots an arrow or bolt when a gun-like trigger is pulled. Crossbows can unexpectedly penetrate soft tissues and bones despite their low initial velocity, causing a wide range of lesions [1]. Penetrating chest trauma caused by crossbows is very rare and mostly reported as suicides, homicides, and accidental cases in forensic studies. According to a review of the literature regarding crossbow injuries, patients survived in only 17 of 55 cases (31%) [2].

Herein, we report a rare case of delayed expanding traumatic pseudoaneurysm of the thoracic aorta caused by a self-inflicted crossbow bolt injury that was successfully treated with early thoracic endovascular

aortic repair (TEVAR). Although penetrating thoracic aortic injuries are typically fatal, particularly when the thoracic aorta is involved, our patient was initially hemodynamically stable without evidence of direct damage to the aortic wall, followed by enlargement of pseudoaneurysm during eight day follow up. Three-dimensional reconstruction of computed tomography (CT) images could be of greatly helpful in determining the wound tract and detecting damage to the surrounding tissue associated with minimal thoracic aorta traumatic pseudoaneurysms. This report is a reminder to emergency physicians about the importance of careful follow up for early detection of growing pseudoaneurysms, even if the bolts do not directly injure the aortic wall.

This work has been reported in line with the SCARE criteria [3].

\* Corresponding author at: Department of Emergency, Critical Care and Disaster Medicine, Okayama University Graduate School of Medicine Dentistry and Pharmaceutical Sciences, 2-5-1 Shikata-cho, Kita-ku, Okayama-shi, Okayama 700-8558, Japan.

E-mail address: [naito-hiromichi@s.okayama-u.ac.jp](mailto:naito-hiromichi@s.okayama-u.ac.jp) (H. Naito).

<https://doi.org/10.1016/j.ijscr.2021.106474>

Received 29 June 2021; Received in revised form 6 September 2021; Accepted 6 September 2021

Available online 7 October 2021

2210-2612/© 2021 The Author(s). Published by Elsevier Ltd on behalf of IJS Publishing Group Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 2. Presentation of case

A 51-year-old male with no medications, no allergy, no smoking, no alcohol, and relevant medical history including psychiatric disease, was admitted to our emergency department with a self-inflicted penetrating chest injury. The patient stated that he attempted suicide by firing a hand-made crossbow bolt twice into his left chest (Fig. 1). The patient was hemodynamically stable with a blood pressure of 151/83 mmHg, heart rate of 94 beats/min, and respiratory rate of 16 breaths/min. He was alert and oriented, with no apparent neurological deficit. He had two stab wounds in his left precordium area. The bolt had already been pulled out by the patient at presentation, and there was no wound in his back. His respiratory sounds were normal without subcutaneous emphysema or respiratory distress, with pulse oximetry of 97% in the room air. The abdomen was flat and soft. Ultrasonography revealed no pericardial effusion without intraperitoneal fluid. Laboratory test results showed no abnormalities. Emergency contrast-enhanced CT revealed left lung contusion, left hemothorax, and a cavity pseudoaneurysm 2.5 mm in size on the aortic arch. Based on the three-dimensional image reconstructed to determine the bolt's possible penetration route, the injuries were likely caused by the bolt (Fig. 2). The patient was given Ringer solution, human tetanus immunoglobulin, tetanus toxoid vaccine and prophylactic antibiotics (cefazolin 3 g/day) on admission. Since the patient remained hemodynamically stable, he was transferred to the psychiatric ward for psychological treatment of presented suicide ideation after careful observation in the intensive care unit for two days. On day eight, follow-up enhanced contrast CT demonstrated enlargement of the pseudoaneurysm from 2.5 mm to 4.0 mm (Fig. 3). Cardiovascular surgery consultants decided to perform TEVAR on day 13 of admission. The postoperative course went well, and the patient was discharged to aftercare on the 20th hospital day. We followed the patient for two months; he has been well without enlargement of the pseudoaneurysm.

## 3. Discussion

The chest and head are often the most commonly injured areas in self-harm cases with crossbow injury [4,5]. We present here a rare case of suicide attempted in an unusual way - with a crossbow. While such a

patient often suffers from a mental illness or drug/alcohol dependence, our patient did not have any history of psychological disease.

Like our patient, patients with non-lethal crossbow injuries often show few symptoms and can remain conscious. The pathophysiology of traumatic pseudoaneurysm of the thoracic aorta caused by blunt chest trauma has been considered arterial wall damage from the intima towards the adventitia. On the other hand, the mechanism of traumatic thoracic aortic pseudoaneurysm caused by penetrating trauma from stabbing or bullet wounds is damage to the aorta from outside to inside [6–8]. Crossbow bolts have little kinetic energy, leading to fewer tissue injuries than those caused by bullets [9,10]. In our patient, the pseudoaneurysm may have been formed by adventitia injury by the crossbow associated with injuries to the surrounding tissue. Initially, we chose the conservative management since the size of pseudoaneurysm of the aortic arch was 2.5 mm in size on admission. Considering the benefits and disadvantages of surgical intervention, we chose conservative management and followed up our patient carefully, even after admission to the psychiatric ward, which enabled early detection of the expanding pseudoaneurysm and preventing delayed intervention.

When a bolt remains in the wound, it is easy to get information on its trajectory. However, it can be challenging to distinguish the real cause of injury after the bolt is removed from the wound. Chest radiogram is the initial screening test used for these trauma patients. Indirect signs suggestive of aortic injury are mediastinal hematoma and widening or concomitant multiple rib fractures. CT should always be performed to assess the organs involved and correctly assess the wound tract.

There is no established therapeutic strategy for traumatic aortic pseudoaneurysm; it depends on the severity of the patients' physical condition or the expanding speed of the pseudoaneurysm. A crossbow arrow or bolt should be invariably left *in situ*, secured against displacement to avert new injuries or worsening of those already incurred, and should only be removed by expert physicians in the hospital [4]. In general, implantation of blood vessel prosthesis has been the established treatment for traumatic aortic pseudoaneurysm. Recently, TEVAR, a less invasive intervention, may be the first-line treatment for traumatic aortic pseudoaneurysm when the anatomical aortic requirements are met [11,12]. Our patient was at high risk for delayed rupture based on CT findings of rapid enlargement of thoracic pseudoaneurysm. Therefore, we believe the present case was a good indication of TEVAR.

## 4. Conclusion

When treating patients with penetrating chest trauma caused by crossbow bolts, emergency physicians should be aware that damage to the surrounding tissue may be accompanied by delayed expansion of a traumatic aortic pseudoaneurysm, even if the bolts do not directly injure the aortic wall. Close monitoring for any signs of further deterioration, as well as aggressive imaging modalities, including contrast-enhanced CT based on understanding of the injury mechanism, enabled us to avoid delays in treatment.

## Sources of funding

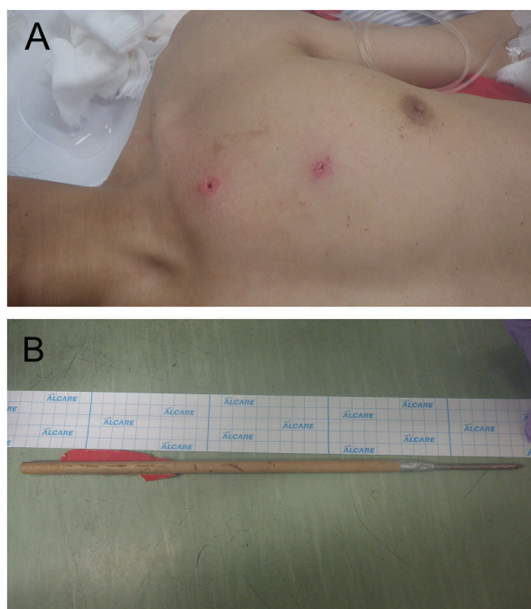
This case report did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Ethical approval

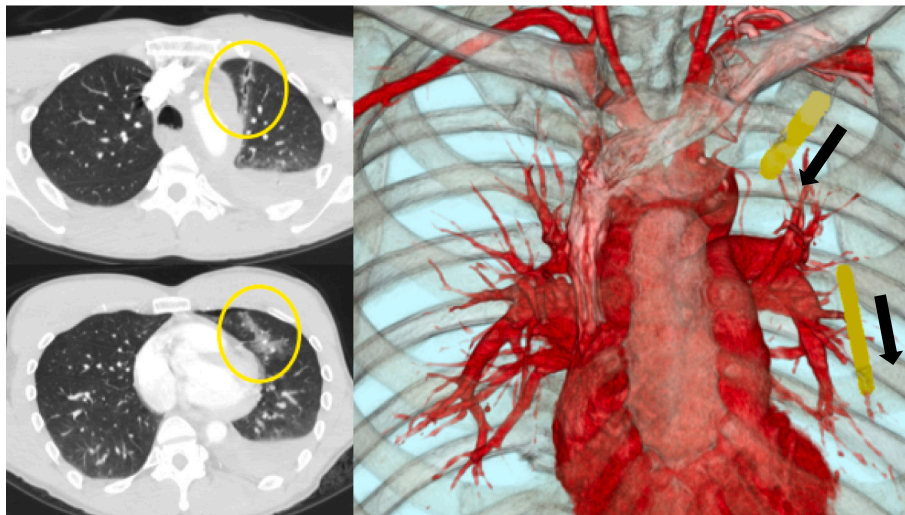
This case study was approved by the ethical committee of Okayama University.

## Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this



**Fig. 1.** (A) Appearance of trauma to the patient's left precordium caused by a crossbow bolt. He shot twice and there was no wound in his back. (B) The handmade crossbow bolt was 41 cm long with a diameter of 5 mm.



**Fig. 2.** The tract of arrows on computed tomography (CT) and three-dimensional reconstruction of the CT image. The path of the bolt can be seen penetrating the anterior lung.



**Fig. 3.** Rapid expansion of the pseudoaneurysm from 2.5 mm to 4.0 mm of the sac depth in the follow-up contrast-enhanced computed tomography on day eight of admission.

journal on request.

**Author contribution**

Shunsuke Nakamura, Taihei Yamada, Hiromichi Naito, Naoya Sakoda and Atsunori Nakao treated the patient and collected data. Shunsuke Nakamura and Atsunori Nakao wrote the paper.

**Registration of research studies**

Not applicable.

**Guarantor**

Hiromichi Naito, Atsunori Nakao.

**Provenance and peer review**

Not commissioned, externally peer-reviewed.

**Declaration of competing interest**

None.

**References**

- [1] A. Giorgetti, M.G. Perdekamp, K. Mierdel, V. Thoma, S. Pollak, D. Geisenberger, Arrow entrance wounds with blackened margins simulating bullet wipe, *Int. J. Legal Med.* 134 (1) (2020) 283–294.
- [2] A. Maiese, P. Santoro, R. La Russa, A. De Matteis, E. Turillazzi, P. Frati, et al., Crossbow injuries: a case report with experimental reconstruction study and a systematic review of literature 79 (2021), 102147.

- [3] R.A. Agha, T. Franchi, C. Sohrabi, G. Mathew, for the SCARE Group, The SCARE 2020 guideline: updating consensus Surgical CAse REport (SCARE) guidelines, *Int. J. Surg.* 84 (2020) 226–230.
- [4] Y. Futamura, H. Watanuki, M. Okada, K. Matsuyama, Penetration of the ascending aorta and bronchus by a crossbow bolt, *Interact. Cardiovasc. Thorac. Surg.* 30 (5) (2020) 792–793.
- [5] D. Ishigami, T. Ota, Traumatic pseudoaneurysm of the distal anterior cerebral artery following penetrating brain injury caused by a crossbow bolt: a case report, *NMC Case Rep. J.* 5 (1) (2018) 21–26.
- [6] T.C. Fabian, J.D. Richardson, M.A. Croce, J.S. Smith Jr., G. Rodman Jr., P. A. Kearney, et al., Prospective study of blunt aortic injury: multicenter trial of the American Association for the Surgery of Trauma, *J. Trauma* 42 (3) (1997) 374–380, discussion 80–3.
- [7] T.J. Dossios, N. Salemis, D. Angouras, E. Nonas, Blunt and penetrating trauma of the thoracic aorta and aortic arch branches: an autopsy study, *J. Trauma* 49 (4) (2000) 696–703.
- [8] J.M. Cappuzzo, K.E. Knudson, S. Sarin, J. Babrowicz, A. Cherrick, J.H. Sherman, Delayed traumatic aortic pseudoaneurysm formation causing vertebral body erosion and Back pain: case report and literature review, *World Neurosurg.* 110 (2018) 232–239.
- [9] M. Frank, W. Schikorr, R. Tesch, R. Werner, S. Hanisch, D. Peters, et al., Ballistic parameters and trauma potential of pistol crossbows 127 (4) (2013) 777–782.
- [10] N. Maiden, Ballistics reviews: mechanisms of bullet wound trauma 5 (3) (2009) 204–209.
- [11] M.H. Murad, A.Z. Rizvi, R. Malgor, J. Carey, A.A. Alkatib, P.J. Erwin, et al., Comparative effectiveness of the treatments for thoracic aortic transection [corrected], *J. Vasc. Surg.* 53 (1) (2011), pp. 193–9 e1–21.
- [12] N. Fox, D. Schwartz, J.H. Salazar, E.R. Haut, P. Dahm, J.H. Black, et al., Evaluation and management of blunt traumatic aortic injury: a practice management guideline from the eastern Association for the Surgery of trauma, *J. Trauma Acute Care Surg.* 78 (1) (2015) 136–146.