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CASE REPORT

Fatal delayed rupture of the subclavian artery in a patient with first-rib fracture caused by blunt trauma

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Key Clinical Message

This case highlights the probable association of significantly displaced posterior first-rib fracture and jagged edges of the fracture line following blunt chest trauma with delayed ipsilateral subclavian artery rupture. Early angiography and first-rib repair should promptly be considered under such circumstances.

Keywords

Angiography, delayed artery rupture, laceration, pseudoaneurysm.

Introduction

Subclavian artery injury due to blunt trauma is rare [1, 2] and often diagnosed soon after the affected upper extremity exhibits symptoms immediately following an injury [1, 3]. Previous studies suggested that subclavian artery injury may be associated with first-rib fracture [4, 5]. The present authors had a patient who was admitted because of blunt chest trauma that included bilateral first-rib fractures without any signs of subclavian artery injury. The patient suddenly developed a left massive hemothorax 35 h after injury due to delayed rupture of the left subclavian artery, and this led to cardiac arrest.

Case

A 55-year-old man was injured when he was struck by a car while riding a motorcycle. When the emergency personnel arrived, he was lucid, his respiratory rate was 27 breaths/min, his SpO_2 was 75% (ambient air), his pulse rate was 110 beats/min, and his blood pressure was 176/108 mmHg. He had severe dyspnea. Based on the physical examination upon arrival at the hospital, right tension pneumothorax was suspected, so a chest tube was promptly inserted. Subjective symptoms resolved and his breathing and circulation stabilized. Plain chest computed tomography (CT) revealed pneumomediastinum, severe subcutaneous emphysema, bilateral hemopneumothorax

(predominantly on the right), pulmonary contusion, fractures of the right first through the seventh ribs, and fractures of the left first and second ribs. No evidence of a hematoma was found around the left subclavian artery. The left first rib was fractured along the long axis of the posterior aspect with anterior displacement of the fragment, leaving a fracture line with jagged edges (Fig. 1). Symptoms indicative of ischemia or brachial plexus injury were not observed in the upper left extremity.

After admission, SpO_2 of about 95% was maintained with 4-L/min oxygen via a nasal cannula. Twenty-five hours after the injury, increased opacity was not observed on plain chest films (Fig. 2A).

Thirty-five hours after the injury, the patient suddenly developed left chest pain and dyspnea. His blood pressure then dropped rapidly, leading to cardiac arrest. Cardiopulmonary resuscitation was begun immediately, and a plain chest film obtained during resuscitation showed decreased translucence in the left lung field (Fig. 2B). An emergency left anterolateral thoracotomy was performed, and massive bleeding into the thoracic cavity was observed. The descending aorta was clamped, and then, right one-lung ventilation was initiated. An attempt was made to locate the site of bleeding in the left thoracic cavity, and arterial bleeding from the apex of the lung into the thoracic cavity was observed. Cardiopulmonary resuscitation was continued while manual pressure was applied to the source of the bleeding in the thoracic cavity. Forty minutes after resuscitation was started, spontaneous circulation returned. Preparations were made for emergency surgery, and angiography was performed to accurately locate the source of the bleeding and control the bleeding via endovascular balloon occlusion. Extravasation of contrast media from the left subclavian artery was observed (arrow in Fig. 3) just past where the left internal thoracic artery originates from the subclavian

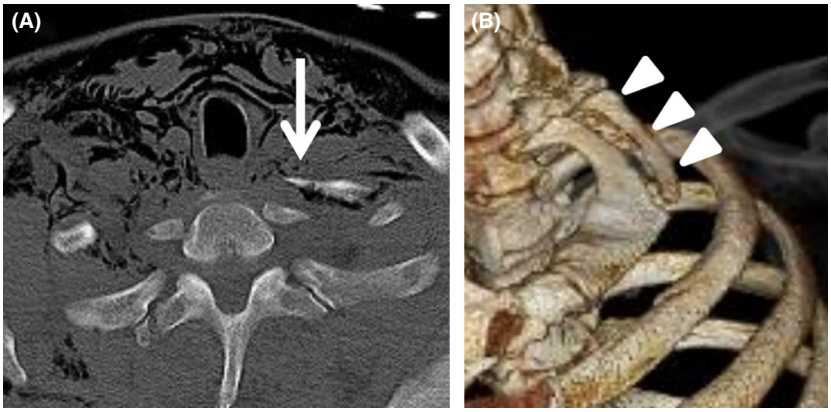

Figure 1. Chest CT (A) and 3D-CT (B) image on admission. Posterior fragment of the fractured first rib with its sharp edge (A, arrow) and with dislocation (B, arrowheads) is shown.

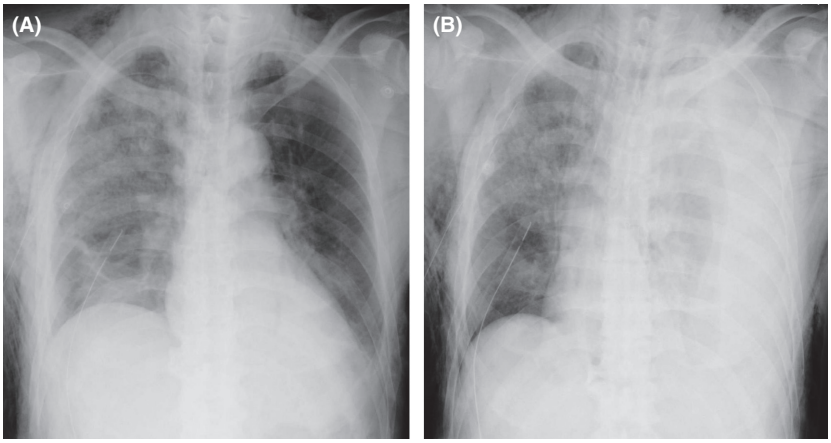

Figure 2. Chest X-ray film at 25 h (A) and at 35 h after injury (B). The latter shows left massive hemothorax.

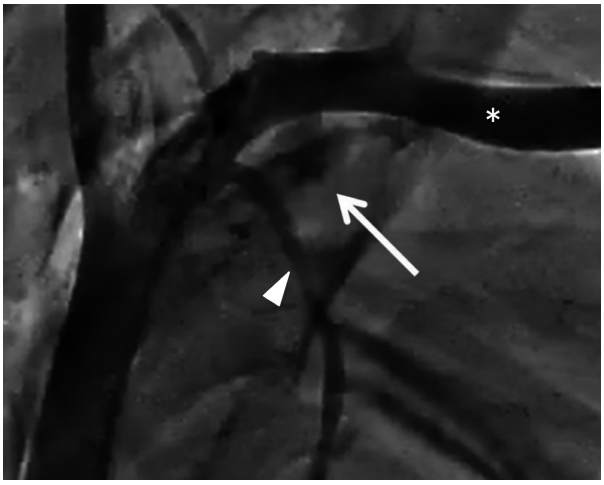

Figure 3. Emergency angiography of the left subclavian artery (asterisk). Extravasation from the point overriding the first rib right after branching the left internal mammalian artery (arrowhead) is shown (arrow).

artery. The patient was diagnosed as having an injury to the left subclavian artery and rupture of the artery in the thoracic cavity. The artery was then occluded with a balloon catheter, and the blood loss volume decreased. However, acute coagulopathy could not be controlled, and the patient died 39 h after injury.

Discussion

Each subclavian artery lies in a groove on the first rib; the subclavian artery passes through the thoracic outlet, with the brachial plexus behind the artery and the attachment of the anterior scalene in front of the artery. Anatomically, the subclavian artery is protected by bone, including the clavicle, first rib, and scapula, so subclavian artery injury following blunt trauma is often due to high-energy trauma that causes a fracture around the thoracic outlet [1, 3].

Costa et al. studied 167 patients with subclavian and superior mediastinal artery injury and found that 15 of the patients had injuries to a subclavian artery following blunt trauma [1]. All 15 of the patients had fractures, with first-rib fracture being the most frequent fracture (in four of the 15 patients). Phillips et al. studied 45 patients with a first-rib fracture due to blunt trauma and found that four of the patients had an injury to a subclavian artery [4]. They divided first-rib fractures into posterior, lateral, and anterior fractures and found that posterior fractures were more likely to result in vascular injury when they extended halfway or more through the rib and were displaced. According to Phillips et al., angiography is indicated if a displaced first-rib facture is present, pulse is absent in the upper extremity, or a brachial plexus injury is present. According to a review of 730 cases of first-rib fracture by Gupta et al., subclavian artery and aortic arch angiographies are indicated (i) when the mediastinum is widened on plain chest films or changes are observed on images over time, (ii) when pulse in the upper extremity is absent or a difference in blood pressure between arms is evident, (iii) the first-rib fracture is displaced posteriorly or the subclavian groove is fractured anteriorly, and (iv) when a brachial plexus injury or expanding hematoma is observed [5].

In the present case, delayed rupture of a subclavian artery occurred in a patient with blunt chest trauma with no signs of subclavian artery injury. A case of delayed hemorrhage from the subclavian vein due to a first-rib fracture was previously reported [6]. However, to the best of our knowledge, no reports in the English literature showed delayed rupture of a subclavian artery after a first-rib fracture. Presumably, delayed rupture occurs via two mechanisms.

The present case involved a fracture of the posterior aspect of the first rib with anterior displacement of the fragment and injury to a subclavian artery due to the proximity of the fracture to the groove for the subclavian artery on the first rib. These circumstances may have produced a pseudoaneurysm that caused delayed rupture of the artery. Angiography after the return of spontaneous circulation did not reveal any obvious vascular abnormalities.

Another mechanism by which delayed rupture of a subclavian artery occurs is when a subclavian artery is directly injured by the jagged edge of a fractured bone. A re-examination of CT images obtained upon the patient's arrival revealed that the neck of the left first rib had substantially separated from its attachment to the first thoracic vertebra due to a fracture of the posterior aspect of that rib. The edges of the fracture line were jagged, and the fracture was near the path of the left subclavian artery after it originated from the aortic arch (Fig. 1). In the present case, body movement may have caused a jagged bone fragment to injure the nearby left subclavian artery.

Some intriguing cases of late-onset aortic injury after traumatic rib fractures have been reported [7–10]. The patients in all the cases developed aortic injury a few days after the onset of trauma and led to the diagnosis of direct aortic puncture by a fractured bone, which was supported by the operative findings. Similarly, from a case of acute-onset fatal subclavian artery rupture associated with isolated clavicle fracture due to accidental injury while blading [11], we should bear in mind that bone fragments can result in vascular injury. Therefore, even if most rib fractures can be managed conservatively, we should suggest rib fixation surgery [12] or the resection

of the rib edges [7–10], especially when the shape of the fractured bone seems at a high risk of vascular injury.

Conclusion

In the event of a first-rib fracture following blunt trauma, angiography and first-rib repair should promptly be considered in accordance with the location and degree of displacement of the fracture and shape of the edges of the fracture line.

Conflict of Interest

None declared.

Authorship

NY: took part in manuscript preparation and submission. YN and TT: participated in literature review and manuscript preparation. TM, MA, TI and TI: performed literature review and critical thinking of the manuscript. All authors read and approved the final manuscript.

References

1. Costa, M. C., and J. V. Robbs. 1988. Nonpenetrating subclavian artery trauma. J. Vasc. Surg. 8:71–75.
2. McKinley, A. G., A. T. Carrim, and J. V. Robbs. 2000. Management of proximal axillary and subclavian artery injuries. Br. J. Surg. 87:79–85.
3. Prêtre, R., P. Hoffmeyer, M. Bednarkiewicz, K. Kursteiner, and B. Faidutti. 1994. Blunt injury to the subclavian or axillary artery. J. Am. Coll. Surg. 179:295–298.
4. Phillips, E. H., W. F. Rogers, and M. R. Gaspar. 1981. First rib fractures: incidence of vascular injury and indications for angiography. Surgery 89:42–47.
5. Gupta, A., M. Jamshidi, and J. R. Rubin. 1997. Traumatic first rib fracture: is angiography necessary? A review of 730 cases. Cardiovasc. Surg. 5:48–53.
6. Rozendaal, F. W., H. J. Bonjer, and H. A. Bruining. 1995. Late haemorrhage from the subclavian vein due to a fracture of the first rib. Injury 26:57–58.
7. Kigawa, I., I. Fukuda, Y. Fujii, and K. Yamabuki. 1992. A sharp edge of the fractured ribs caused the aortic injury at bodyposition change: a case report. Nihon Kyobu Geka Gakkai Zasshi 40:1116–1120.
8. Iyoda, A., N. Satoh, H. Yamakawa, M. Fujino, K. Hiroshima, and T. Fujisawa. 2003. Rupture of the descending thoracic aorta caused by blunt chest trauma: report of a case. Surg. Today 33:755–757.
9. Bruno, V. D., and T. J. Batchelor. 2009. Late aortic injury: a rare complication of a posterior rib fracture. Ann. Thorac. Surg. 87:301–303.
10. Morimoto, Y., T. Sugimoto, H. Sakahira, H. Matsuoka, Y. Yoshioka, and H. Arase. 2014. Successful management of threatened aortic rupture late after rib fracture caused by blunt chest trauma. Ann. Vasc. Surg. 28:1035. e11–13.
11. Kendall, K. M., J. H. Burton, and B. Cushing. 2000. Fatal subclavian artery transection from isolated clavicle fracture. J. Trauma 48:316–318.
12. Wada, T., H. Yasunaga, R. Inokuchi, H. Matsui, T. Matsubara, Y. Ueda, et al. 2015. Effectiveness of surgical rib fixation on prolonged mechanical ventilation in patients with traumatic rib fractures: a propensity score-matched analysis. J. Crit. Care 30:1227–1231.

