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Delayed massive hemothorax due to diaphragm injury with rib fracture: A case report

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ABSTRACT

INTRODUCTION: Delayed massive hemothorax after blunt trauma is rare, although associated with significant morbidity and mortality. In most cases, the intercostal artery is the main bleeding source. We report a rare case of delayed massive hemothorax due to a diaphragm injury with a lower rib fractures.
PRESENTATION OF CASE: A 58-year-old man, transported to our hospital four hours after a 2-meter fall from a ladder, had left-sided fractures to ribs 11 and 12, thoracic and lumbar vertebral fractures, and traumatic subarachnoid hemorrhage. On admission, no left hemothorax was documented; however, 17 h post-injury he developed hypovolemic shock. Plain chest radiographs showed a massive left hemothorax with a mediastinal shift. Chest contrast-enhanced computed tomography revealed extravasation of the contrast agent in the chest cavity. No intercostal arterial bleeding was evident on emergency angiography. A left anterolateral thoracotomy through the 6th intercostal space revealed rib fractures and active bleeding from the dorsal side of the left hemidiaphragm. Suture hemostasis was performed for the diaphragm injury and the disrupted ribs were repaired.
DISCUSSION: Embolization of diaphragm-feeding arteries is not a simple or fast procedure. Clinically, predicting delayed hemothorax is challenging, and careful observation of trauma patients with lower rib fractures is needed. Thoracotomy should be considered for immediate hemostasis in patients with sudden shock, with complete hematoma drainage and repair of the disrupted rib.
CONCLUSION: Diaphragmatic injury with lower rib fractures can result in delayed hemothorax, requiring thoracotomy.
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1. Background

Patients frequently present with minor trauma-related thoracic injuries at emergency departments; however, delayed massive hemothorax due to blunt trauma resulting from minor injury is rare [1]. Blecher et al. highlighted difficulties in identifying patients deteriorating due to massive hemothorax with no signs of respiratory failure and shock [2], reporting that delayed life-threatening hemothorax is rare and can be easily missed [2,3]. Delayed massive hemothorax usually results from an injury involving various arteries in the thoracic space and is associated with significant morbidity and mortality. Over the last decade, reports concerning patients with hemothorax have indicated that the most frequent source of bleeding was from the intercostal artery, which was subsequently treated using interventional radiology (IVR) [4–9]. Here, we report a rare case of delayed massive hemothorax due to a diaphragm injury following lower rib fracture. Specialists at our hospital performed all the examination and intervention procedures when treating this patient. This case report complies with SCARE criteria guidelines [10].

2. Case presentation

A 58-year old man was transported to our hospital four hours after falling from a 2-meter high stepladder. He had no relevant medical or medication history nor any family history of bleeding diathesis. His 11th and 12th ribs were fractured, as were the left transverse process of the 11th thoracic vertebra, and the left transverse processes of the 1st, 2nd, and 3rd lumbar vertebrae. He also presented with a traumatic subarachnoid hemorrhage. On hospital admission, no left hemothorax was detected (Fig. 1a); therefore, conservative therapy was administered and he was admitted to the emergency ward and placed on bedrest. Seventeen hours post-injury, he suddenly went into shock. His blood pressure and heart rate were 72/54 mmHg and 126 beats per minute, respectively. A chest radiograph showed a left massive hemothorax with a mediastinal shift (Fig. 1b). A tube thoracostomy was performed

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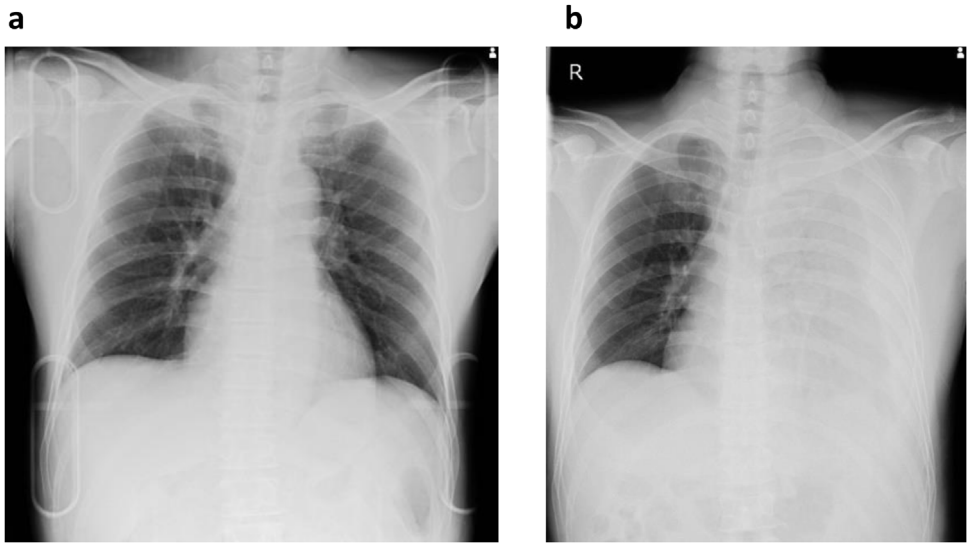

Fig. 1. (a) Chest X-ray on admission showed no evidence of hemothorax. (b) Chest X-ray showed massive left hemothorax and deviation of the trachea.

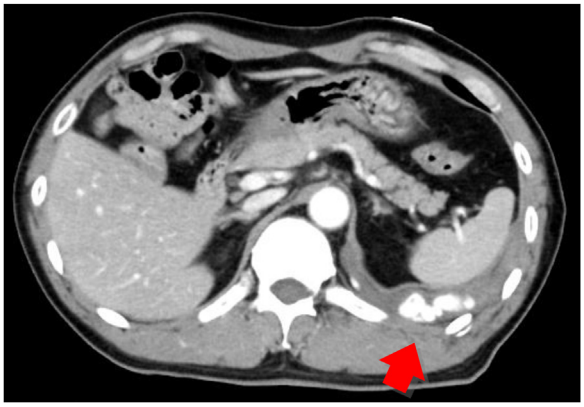

Fig. 2. Chest contrast-enhanced CT showed a massive left hemothorax, and extravasation in front of the 11th left rib fracture.

immediately, and approximately 1000 mL of blood was evacuated initially. The massive transfusion protocol was invoked, and a non-cross O+ blood transfusion was started. Contrast-enhanced computed tomography of the chest following fluid resuscitation revealed extravasation of the contrast agent around the ventral side of the 11th left rib fracture (Fig. 2). An emergency angiography showed no signs of intercostal arterial injury. His vital signs began to deteriorate; therefore, a decision was made to perform video-assisted thoracic surgery as an alternative to a significant transfusion. After entering the operating room, his systolic blood pressure dropped to 50 mmHg. Because of the unstable hemodynamic status, a left anterolateral thoracotomy through the 6th intercostal space was performed. The left pleural cavity was found to be filled with blood clots. The thoracotomy revealed a fracture of the 11th rib along with active bleeding from the dorsal side of the left hemidiaphragm without perforation. The diaphragmatic injury was treated with suture hemostasis, and the fractured rib was repaired (Fig. 3). The final total transfusion volume was 12 units of red blood cells, 10 units of fresh frozen plasma, and 10 units of platelets. Post-operative recovery was uncomplicated and he was transferred from the intensive care unit to a general ward on day 3 and discharged on day 30. The patient adhered to treatment and appeared to tolerate all interventions well.

3. Discussion

Ritter et al. defined delayed hemothorax as no evidence of hemothorax present on first examination but subsequently detected and confirmed after further clinical investigations. The time gap between the first and subsequent investigations can be as little as two hours [11]. Our patient showed no evidence of hemothorax at admission to our hospital. As his hemothorax developed 17 h later, he was diagnosed with delayed hemothorax.

Previous studies have reported the incidence of delayed hemothorax after blunt chest trauma to range from 2.1%–33% [7,12,13]. It has been reported that 92% of delayed hemotho-

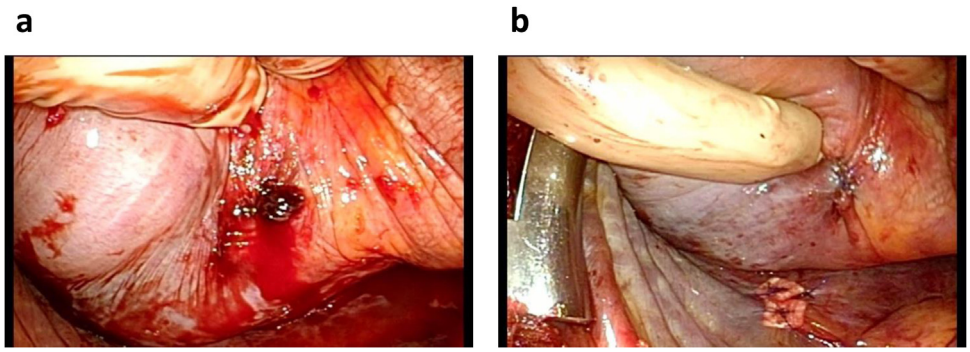

Fig. 3. (a) Under thoracoscopy, active bleeding from the left hemidiaphragm was seen.
(b) Suture hemostasis of the diaphragmatic injury and repair of the fractured ribs.

Table 1
Studies concerning delayed hemothorax due to blunt trauma requiring surgical intervention or IVR reported in the English literature (References: [4,5,9,12,18–23]).

No	Year	Author	Age/sex	Mechanisms	Time from onset	Extent rib fracture	Surgery	Cause	Outcome
1	1998	Simon	N/A	N/A	18h-6days	N/A	Thoracotomy	Intercostal artery	Survived
2	1998	Simon	N/A	N/A	18h-6days	N/A	Thoracotomy	Intercostal artery	Survived
3	2004	Misthos	N/A	N/A	2–14 days	N/A	Thoracotomy	Intercostal artery	Survived
4	2004	Misthos	N/A	N/A	2–14 days	N/A	Thoracotomy	Intercostal artery	Dead
5	2013	Masuda	56/M	Fall	30days	Left 10th	Thoracotomy	Extra pleural cavity	Survived
6	2014	Chen	60/M	Fall	6days	Right 10th-11th	VATS	Diaphragm	Survived
7	2015	Yamanashi	75/M	Motorcycle accident	24h	Right 7th-8th,10th-11th	IVR→VATS	Diaphragm	Survived
8	2015	Curfman	29/M	Assault	10days	Left 7th	Thoracotomy	Intercostal artery	Survived
9	2016	Ahn	24/F	Fall	13days	Right 11th-12th	VATS	Musculophrenic artery	Survived
10	2017	Lin	19/M	Assault	12hours	None	Thoracotomy	Diaphragm	Survived
11	2018	Chang	52/M	Fall	93h	Left 4th-10th	Thoracotomy	Diaphragm	Survived
12	2018	Chang	44/M	Slip	63h	Right 8th-10th	VATS→Thoracotomy	Diaphragm	Survived
13	2018	Chang	45/M	Motorcycle accident	66h	Left 10th-12th	Thoracotomy	Diaphragm	Survived
14	2018	Chang	59/M	Pedestrian traffic accident	63h	Right 1st-11th	Thoracotomy	Diaphragm	Survived
15	2018	Chang	31/M	Motor vehicle accident	33h	Right 3rd-8th	VATS→Thoracotomy	Diaphragm	Survived
16	2019	Igai	44/F	N/A	22days	Right 9th-12th	VATS	Diaphragm	Survived
17	2019	Igai	55/F	N/A	30days	Left 9th-11th	Thoracotomy	Diaphragm	Survived
18	2019	Igai	85/F	N/A	15days	Left 9th-11th	Thoracotomy	Diaphragm	Survived
19	2019	Igai	57/F	N/A	14h	Right 5th-12th	Thoracotomy	Diaphragm	Survived
20	2020	The present case	58/M	Fall	17h	Left 11th-12th	IVR→Thoracotomy	Diaphragm	Survived

Abbreviations: IVR, interventional radiology; N/A, no available information; VATS, video-assisted thoracic surgery.

rax cases showed evidence of either multiple rib fractures or a solitary displaced fracture [9]. Other sources of bleeding involve intrathoracic organs aside from the chest wall [3,7,9,12,14,15]. Injuries to the diaphragm, lung, and thoracic aorta have also been reported to cause hemothorax, along with intercostal artery injury [7,9,12,14,15].

In our patient, hemothorax in relation to the left lateral 11^{th}–12^{th} rib fractures was consistent with these reports. Most causes of delayed hemothorax are related to traumatic injury of the intercostal artery resulting from rib fractures [7]. However, for our patient, interventional radiology (IVR) was used to evaluate the artery as we suspected that the bleeding point was the intercostal artery itself but no bleeding was detected from the intercostal artery. Diaphragmatic injury, lung injury, and thoracic aortic injury have been reported to cause hemothorax, except for injury of the intercostal artery [7,9,12,14,15].

A diaphragmatic injury has been reported to be uncommon in cases of blunt chest injury. A diaphragmatic rupture can cause herniation of the intra-abdominal organs, thereby disturbing respiration. However, a massive hemothorax due to diaphragmatic injury is rare. Diaphragmatic injuries have been reported in approximately 5% of patients with blunt chest trauma, and the most common cause is a fracture of the ribs on the caudal side, caudal to the 10^{th} rib, with minor trauma [16]. Even in cases of upper rib fracture, if the bone fragment protrudes into the thoracic cavity, the risk of diaphragm injury may be high. In our patient, the operative findings revealed that the left 11^{th}, and 12^{th} ribs were fractured, and bone fragments protruded into the thoracic cavity, resulting in diaphragmatic injury and bleeding. Arteries feeding the diaphragm comprise the pericardiophrenic artery; the musculophrenic artery, branching from the internal thoracic artery, and; the inferior phrenic artery, branching from the abdominal aorta or the celiac artery [17]. Yamanashi et al. [18] reported that hemostasis in the vicinity of damaged blood vessels is important for controlling bleeding. However, without embolize the peripheral part, which is the source of bleeding, embolizing from the root

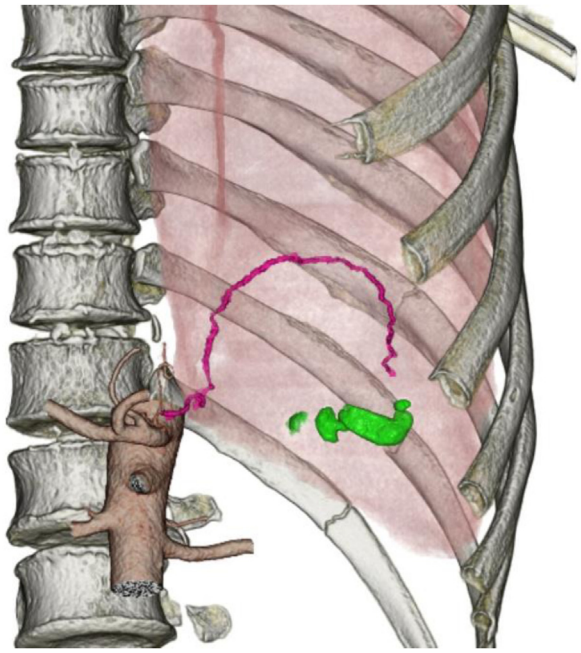

Fig. 4. CT angiography showed a contrast agent leak originating from the right inferior phrenic artery.

of vessels, achieving hemostasis is challenging, and our patient did not undergo angiography of the obstructed vessels. This case involved an emergency situation; therefore, the reconstructed CT image could not be carefully evaluated at the time. However, a subsequent CT evaluation was undertaken and the inferior phrenic artery was suspected to be the bleeding vessel (Fig. 4).

The effect of embolization of the intercostal artery or the internal thoracic artery on hemostasis in the diaphragm is not clear. Since embolization of the inferior phrenic, pericardiophrenic, and

musculophrenic arteries is not a simple procedure, a lengthy surgical intervention is required to stop bleeding in the diaphragm. If the vital signs are unstable, these arteries should not be sticked for IVR [19]. Therefore, prolonged IVR would have increased the risks for our patient.

In general, the surgical indication for massive hemothorax depends on the amount of bleeding and the vital signs after thoracic drainage. For patients with massive bleeds or poor hemodynamics, transfusion and an emergency thoracotomy should be performed without delay. In our patient, thoracotomy was performed because of an unstable hemodynamic status due to a massive hemothorax during IVR. Since the bleeding point was on the ventral side of the 11th rib, thoracotomy was performed in the 6th–7th intercostal space. The rib fractures, which may have caused the diaphragm injury, were also sutured and fixed.

In cases of diaphragmatic injury, empyema due to hematoma infection has been reported after non-operative management (NOM) of massive hemothorax. NOM, including IVR, cannot completely remove a hematoma in the thoracic cavity [18]. Recently, some studies have reported performing an operation for diaphragmatic injury under complete thoracoscopy. However, we found no reports of rib repair under complete thoracoscopic surgery. Moreover, we considered undertaking complete thoracoscopic surgery to repair the disrupted ribs would have been difficult for our patient. Furthermore, hemostasis under assisted thoracoscopy helped to detect the diaphragmatic bleeding point in the thoracic cavity.

Table 1 shows data concerning 19 cases of delayed hemothorax requiring surgery or IVR reported in the literature, as well as information concerning our patient. Most cases that required intervention involved bleeding due to diaphragmatic injury. In addition, as previously reported, all had lower rib and multiple fractures [3]. In almost all cases, thoracotomy was performed to obtain hemostasis.

In clinical practice, predicting a delayed hemothorax is difficult. Therefore, it is important to carefully observe trauma patients with lower rib fractures. If a patient suddenly develops shock, thoracotomy needs to be considered for immediate hemostasis, complete drainage of the hematoma, and repair of the disrupted rib.

4. Conclusion

A diaphragmatic injury with lower rib fractures can cause delayed hemothorax, and thoracotomy needs to be considered in such cases.

Declaration of Competing Interest

The authors report no declarations of interest.

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

Ethical approval

This study is exempt from ethical approval in our institution.

Consent

Written informed consent was obtained from the patient for the publication of this case report and any accompanying images.

Author contribution

TM drafted the article and performed the surgical intervention. AK, KO, MK, SK, EH, YS, and HW carried out the data acquisition. HW participated in the critical revision of the manuscript. All authors have read and approved the manuscript. TM is guarantor of the paper.

Registration of research studies

In this case report, we are not performing a new surgical technique nor are we using a new device for the first time.

Guarantor

TM is guarantor of the paper.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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