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## Case Report

# A case of hemorrhagic shock due to intercostal artery injury that occurred during initial trauma care with multiple displaced rib fractures and traumatic head injury<sup>☆</sup>

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## ABSTRACT

Rib fractures can cause injury to some organs. We herein report a case of hemorrhagic shock due to intercostal artery injury that occurred during initial trauma care (ITC) treated by resuscitative thoracotomy (RT) and transcatheter arterial embolization (TAE) with multiple displaced rib fractures (RFs) and traumatic head injury (THI). A man in his 50s who was injured in a traffic accident was transferred to our institution by helicopter for emergency medical treatment. He underwent left thoracic drainage on site. On admission, he was diagnosed with multiple RF, THI, pelvic fracture and right humerus fracture. His D-dimer and fibrin degradation products (FDP) level were extremely elevated. However, contrast enhance CT (CECT) revealed no extravasation. At 2 h after arrival, massive hemorrhaging from his thoracic tube suddenly occurred and his blood pressure decreased to approximately 40s mmHg. CECT performed after volume resuscitation and massive transfusion revealed extravasation from the intercostal artery. Because his blood pressure could not be maintained by massive transfusion, we performed RT and TAE followed by RT. He then received intensive care and several surgical procedures were performed, including craniotomy for removal of hematoma, rib fixation and humerus fixation. He was transferred to another hospital for rehabilitation on day 63, with a GCS of 15. Hemorrhagic shock due to intercostal artery injury may occur at any time from arrival in cases with displaced RF, especially when complicated by THI.

## Introduction

Rib fractures (RFs) can cause injury to some organs [1–7], and displaced rib fractures are particularly dangerous [3–7]. We herein

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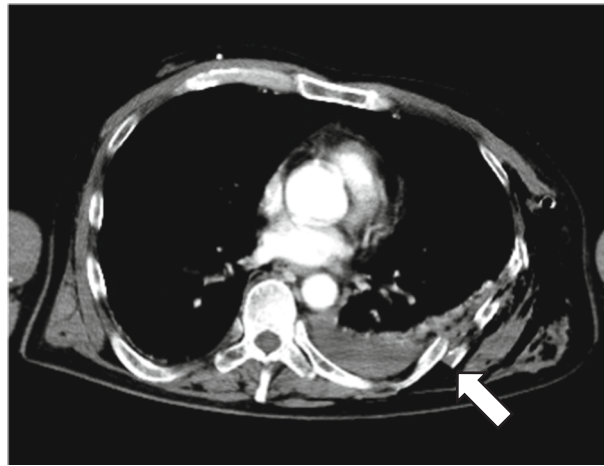
report a case of hemorrhagic shock due to intercostal artery injury that occurred during initial trauma care treated by resuscitative thoracotomy (RT) and transcatheter arterial embolization (TAE) with multiple displaced RFs and traumatic head injury (THI).

## Case presentation

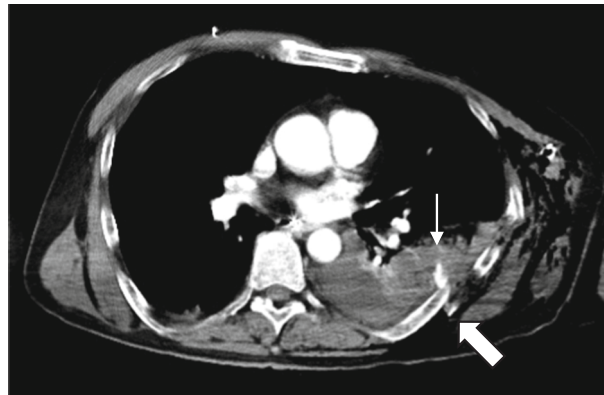
A man in his 50s was struck by a motor vehicle while riding a motorcycle and transferred to our institution by helicopter for emergency medical treatment 1 h after the accident. The emergency physician who boarded the helicopter performed left thoracic drainage onsite due to suspected left pneumothorax. A physical examination on admission revealed the following: Glasgow Coma Scale (GCS), 14 (E4, V4, M6); heart rate, 116 beats/min; blood pressure, 124/94 mmHg; respiratory rate, 32 breaths/min; percutaneous oxygen saturation, 98% with 9 L/min of oxygen by reservoir mask. A laboratory analysis revealed significant elevation of the white blood cell count and fibrin degradation products (FDP) and D-dimer (D—D) levels (Table 1). X-ray revealed left multiple RF, left subcutaneous emphysema, and stable pubic fracture. Plain CT (PCT) revealed left brain contusion, left multiple RF (3rd to 11th, 7th to 10th were displaced), left subcutaneous emphysema, right humerus fracture and sacral fracture. Contrast enhanced CT (CECT) revealed no massive hemorrhaging (Fig. 1). After image inspection (70 min after arrival), he complained of worsening respiratory distress. Tracheal intubation was performed, and mechanical ventilation was started. When the patient was ready to enter the ICU (approximately 120 min after arrival), his blood pressure decreased and left hemothorax gradually increased; the hemorrhaging volume was a few hundred milliliters for the first 2 h but increased to 500 ml within subsequent hour. His blood pressure decreased to 40/19 mmHg. Fluid resuscitation and massive transfusion were immediately initiated; the systolic blood pressure increased to 124/78. CECT was performed again, revealing active hemorrhaging from the 7th intercostal artery (ICA) in the pleural cavity (Fig. 2). Because the patient's blood pressure decreased again after the second CECT scan, we performed RT immediately for hemostasis. Anterolateral thoracotomy was performed at the 5th intercostal region. A large hematoma was observed in the pleural cavity, which we evacuated. Massive hemorrhaging appeared at the site of 6th to 9th rib fracture, especially the 7th rib fracture part. Hemostasis was achieved with suturing and ablation, and towel packing and open chest management were performed. After thoracotomy, redetection of CECT revealed persistent hemorrhaging from ICA intermuscularly and at the circumference of the pelvis. We additionally performed angiography and embolization to the left ICA (6th to 9th), bilateral internal iliac artery, right 4th lumbar artery and right inferior epigastric artery (IEA). N-butyl-2-cyanoacrylate (NBCA) was used for the left 6th ICA and right IEA, gelatin sponge was used for other arteries. The patient then entered the ICU. From arrival to ICU admission, the hemorrhaging volume from pleural cavity was approximately 4000 ml and the volume of venous infusion was approximately 5000 ml. During this period, 44 units of red blood cells, 50 units of fresh frozen plasma and 20 units of platelets were transfused. Then, TAE for the circumference of pelvis, removal of the towel from the pleural cavity, chest wall closure (day 1), craniotomy for removal of hematoma (day 1), surgical rib fixation (day 2), humerus fixation (day 8), and tracheostomy (day 13) were performed. Mechanical ventilation was performed on days 0–50. Hemodialysis was performed for acute kidney injury on days 7–38. Finally, the patient was transferred to another hospital for rehabilitation on day 63, with a GCS of 15. (Fig. 3).

**Table 1**  
Laboratory test on admission.

Test	Result	Reference range
WBC ( $\times 10^3/\mu\text{l}$ )	32.6	3.5–9.5
Hb (g/dl)	15.3	10.8–15.5
Plt ( $\times 10^4/\mu\text{l}$ )	18.6	12.7–32.2
PT (%)	73	70–140
PT-INR	1.18	0.90–1.10
APTT (sec)	35.3	25.0–35.0
Fibrinogen (mg/dl)	274	200–400
FDP ( $\mu\text{g/ml}$ )	1155	0.0–10.0
D-D ( $\mu\text{g/ml}$ )	284.5	0.0–1.0
CRP (mg/dl)	0.07	0.00–0.30
T-Bil (mg/dl)	0.42	0.20–1.20
AST (U/l)	124	8–35
ALT (U/l)	91	5–43
$\gamma$ -GTP (U/l)	88	8–38
LDH (U/l)	742	119–229
CPK (U/l)	249	36–177
Amy (U/l)	62	44–132
BUN (mg/dl)	11	8.0–23.0
CRE (mg/dl)	0.72	0.60–0.90
Na (mg/dl)	138	136–148
K (mg/dl)	3.8	3.6–4.8
Cl (mg/dl)	107	98–108
pH	7.377	7.350–7.454
pCO <sub>2</sub> (mmHg)	39.9	32.0–45.0
pO <sub>2</sub> (mmHg)	52	83.0–108.0
Lac (mmol/l)	2.1	0.5–1.6
Base (mmol/l)	−1.5	−5



**Fig. 1.** Contrast enhanced CT on arrival. Displaced 7th rib fracture was detected ( $\Rightarrow$ ). There was no extravasation.

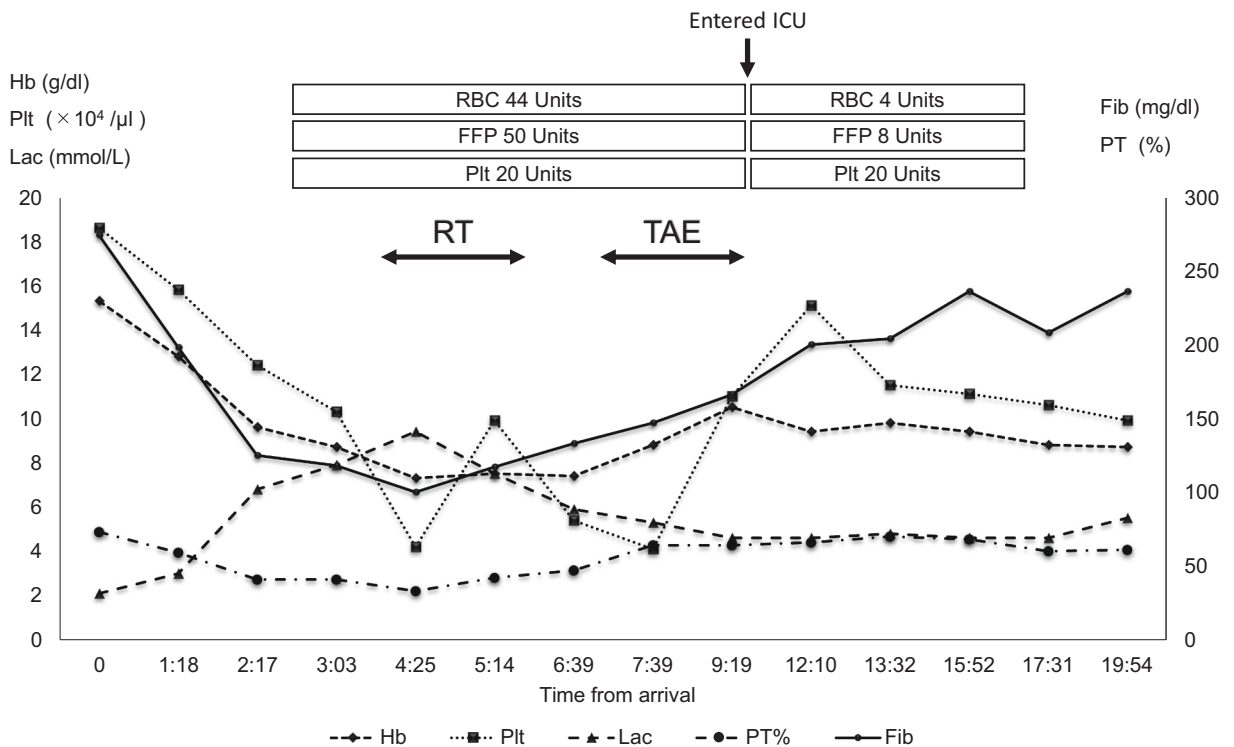


**Fig. 2.** Contrast enhanced CT approximately 120 min after arrival. Displaced 7th rib fracture was detected ( $\Rightarrow$ ). Extravasation was detected ( $\blacksquare$ ).

## Discussion

RFs induce complications such as chest pain, hemothorax, pneumothorax, extra pleural hematoma, pulmonary contusion, pulmonary laceration and vascular injury [1]. Barnea et al. reported pulmonary complications among 28 of 77 elderly patients ( $\geq 65$  years old) [2]. In contrast, vascular injury is quite rare, and some cases have been associated with hemorrhagic shock [1,3–5]. In some instances, vascular injury occurs after admission, with the time of the onset ranging from 17 h to 16 days [3–7]. The mechanism of injury involves bone fragments protruding into the thoracic cavity [5] or the stump coming in contact with an organ [6]. In the present case, since the hemorrhaging from the ICA was induced by a displaced RF, the stump might have come in contact with the ICA. In addition, the THI might have been caused by the hemorrhaging. Hemorrhaging from the ICA was not identified on initial CECT, but it became clinically evident during ITC. Fibrinolysis and fibrinogenolysis are reportedly supranormal during the acute phase of head injury, and this increase correlates with a decrease in the activity of the  $\alpha 2$ -plasmin inhibitor system [8]. In the present case, FDP and D–D values were significantly elevated on admission, suggesting a hyperfibrinolytic state. Thus, bleed clots may have collapsed easily, leading to rebleeding.

Recently, TAE was recommended for ICA bleeding because of its less invasive nature [9]; however, early operative management is needed for massive hemothorax. Especially, urgent thoracotomy is needed for cases with blood loss of  $>1500$  ml of blood or 150–200 ml/h bleeding from chest for 2–4 h, and transfusion is required to maintain hemodynamic stability [10]. Our patient's state was life-threatening; the hemorrhaging was controlled by RT and TAE followed by RT.



**Fig. 3.** The clinical course.  
 RBC: red blood cell, FFP: fresh frozen plasma, Plt: platelet, RT: resuscitative thoracotomy, TAE: transcatheter arterial embolization, Lac: lactate, Hb: hemoglobin, Fib: fibrinogen, PT: prothrombin time.

**Conclusion**

Hemorrhagic shock due to intercostal artery injury may occur at any time from arrival in cases with displaced RF, especially when complicated by THI. Physicians should not hesitate in performing RT for life-threatening cases.

**Authors' contribution**

All authors treated the patient.

**Declaration of competing interest**

The authors declare that they have no conflict of interests.

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