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CASE REPORT

Penetrating cardiac injury caused by multiple rib fractures following high-energy trauma: Usefulness of the exploratory video-assisted thoracoscopic surgery

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Abstract

Background: Penetrating cardiac injuries are usually fatal and associated with poor survival rates.

Case Presentation: A 69-year-old man was injured in a motor vehicle accident and suffered from left hemothorax and multiple rib fractures near the heart. A comprehensive assessment raised suspicions of lacerated pericardium and myocardial injury. Consequently, a thoracoscopy was performed 9 h after injury. A penetrating cardiac injury was detected and surgically treated via video-assisted thoracoscopic surgery. The patient recovered uneventfully and was discharged on postoperative day 16.

Conclusion: Exploratory video-assisted thoracoscopic surgery may play a key role in the primary diagnosis of patients with high-energy chest traumas with cardiac injury and simultaneously allow for the appropriate surgical interventions.

KEYWORDS
penetrating injury, rib fracture, trauma, troponin, video-assisted thoracoscopic surgery

INTRODUCTION

Penetrating cardiac injury is the most lethal injury, and 80% of affected patients die before they reach a hospital.[1] Cardiac injuries are usually fatal due to the associated cardiac rupture, hernia, and/or tamponade and the difficulty in diagnosis and treatment; therefore, early detection is critical. However, survivors of penetrating cardiac injury caused by blunt chest trauma are rare. Multidisciplinary assessment is usually required as the evaluation of clinical imaging findings is limited in patients with multiple trauma. Herein, we report a case of penetrating cardiac injury in which exploratory video-assisted thoracoscopic surgery (VATS) was useful to achieve a definitive diagnosis, allowing for the appropriate surgical intervention.

CASE PRESENTATION

A 69-year-old man with untreated hypertension was transported to our hospital 4 h after being injured in a motor vehicle accident. The patient was conscious and his body temperature was 36.6°C, heart rate was 75 bpm, blood pressure was 186/115 mmHg, respiratory rate was 18 breaths/min, and oxygen saturation was 96% (nasal cannula, 1 L). Laboratory data showed elevated troponin I (0.149 ng/mL) and CK-MB (27.3 U/L) levels. Electrocardiography revealed premature ventricular contraction and an incomplete right bundle branch block, but no remarkable findings were observed on echocardiography. Contrast-enhanced computed tomography showed serial fractures from the left fourth to seventh ribs. The sixth rib was protruding into the thoracic

K.T. and H.H. contributed equally to the writing of this article.

cavity toward the heart (Figure 1). The fifth rib was fractured near the heart, and the seventh rib was fractured near the diaphragm. A small pleural effusion, suspected to be a hemothorax, was observed in the left thorax. However, it was not increasing in size; therefore, drainage was not conducted. Surgery was considered to repair the rib fractures. However, extravasation into a liver cyst was identified, and the bleeding needed to be stopped by interventional radiology (IVR) prior to surgery while the patient's vital signs were stable. Nine hours after the injury, following IVR, the CK-MB level decreased to 15.7 U/L, and the troponin I level increased to 1.009 ng/mL. Cardiac injury was suspected and exploratory VATS was immediately performed. The assessment showed that the left ventricular wall was crushed below the injured pericardium on the anterior side of the phrenic nerve (Figure 2). Although the phrenic nerve was intact, the diaphragm was damaged, though no penetrating injury to the abdominal cavity was observed. The coronary arteries were not injured, and there was no bleeding in the damaged area. A fragment of the sixth rib was protruding into the thoracic cavity; however, no pulmonary fistula was observed. The injury to the left ventricular wall did not penetrate deep into the lumen; therefore, it was closed horizontally using a U-shaped suture with 4-0 non-resorbable polypropylene with felt, and covered with collagen-fibrin patch (TachoSil®). The lacerated pericardium was sparsely sutured to prevent cardiac tamponade and hernia. The scattered bone fragments were removed, and the fifth and sixth ribs were repaired using bioresorbable plates (SUPER FIXSORB-MX®) as braces. The diaphragm was not repaired as the injury had not penetrated the abdominal cavity. After placing a 20-Fr. double lumen chest tube to the anterior side and a 28-Fr. single lumen chest tube to the posterior side, the operation was complete. The patient was able to maintain adequate ventilation and oxygenation. He was extubated on postoperative day 2. The chest tubes were removed on postoperative day 4. Paroxysmal atrial fibrillation appeared transiently, but improved after the administration of beta-blockers. The patient's myocardial enzyme levels gradually decreased, and he was discharged from the hospital on postoperative day 16.

No major abnormalities were noted 3 months postoperatively (Figure 3).

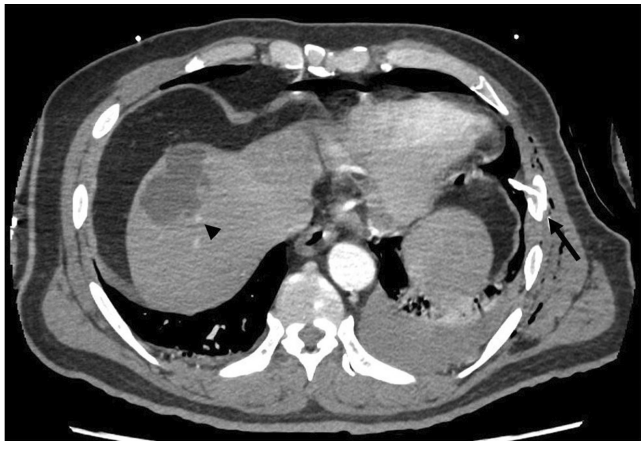

FIGURE 1 Contrast-enhanced computed tomography image of the thoracic cavity. Contrast-enhanced computed tomography shows left serial fractures from the fourth to the seventh ribs with pleural effusion, suspected to be a hemothorax, and the protrusion of the sixth rib into the thoracic cavity toward the heart (arrow). It also shows extravasation into a liver cyst (arrowhead).

DISCUSSION

It was suggested that the increased troponin I level, hemothorax, and cardiac injury in the current patient had resulted from the collapse of the thoracic cage. An exploratory VATS was useful for concurrently determining the patient's condition and performing the appropriate surgical intervention.

Previous studies have reported that elevated troponin I levels and electrocardiogram and echocardiography abnormalities indicate blunt cardiac injury and that patients with rib fractures and hemothorax are at high risk for blunt cardiac injury.[2–5] These examinations have high specificity, but low sensitivity. In addition, the thoracic cage is elastic and tends to return to its original form if the chest organs are severely damaged by a large amount of force; therefore, the presence of mediastinal injuries is difficult to confirm. Injury to the mediastinal organs should be considered by evaluating the direction of force at the injury site and the patient's medical history.

In this patient, left rib fractures and right-sided liver injury were detected, suggesting that the chest was subjected to a large amount of force. No major injury to the heart was detected in the radiographic or echographic examinations; however, the laboratory data were suggestive of cardiac injury. Therefore, an exploratory VATS was conducted to assess the injuries and repair the fractured and protruding ribs.

At our institution, after the assessment of the patient's injuries and condition, surgical interventions are provisionally considered in patients with intrathoracic organ injury with life-threatening hemoptysis and/or diaphragmatic

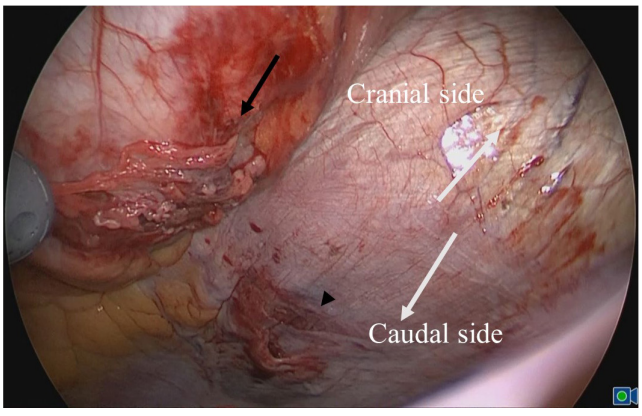

FIGURE 2 Intraoperative image. The intraoperative evaluation shows a crushed left ventricular wall below the injured pericardium on the left anterior side of the phrenic nerve (arrow), and injury to the diaphragm (arrowhead). The left phrenic nerve was preserved.

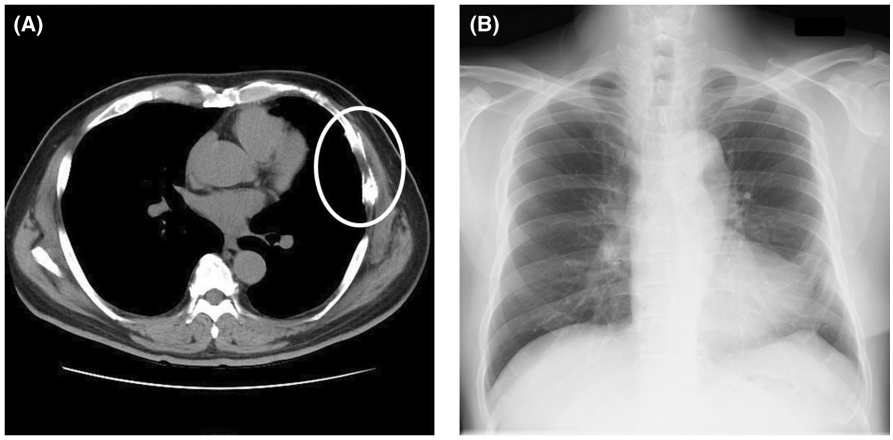

FIGURE 3 Computed tomography and chest radiographic images 3 months postoperatively. The computed tomography and chest radiographic images obtained 3 months postoperatively show no existing injuries. (A) The left fifth and sixth ribs are sandwiched between the artificial plates (encircle), and no ventricular aneurysm is observed. (B) The left fourth to seventh rib fractures are repaired, and the left diaphragm remains unelevated.

penetration; multiple bone fractures resulting in further collapse of the thoracic cage, respiratory failure, and fractured bone protruding into the thoracic cavity with or without sticking the intrathoracic structures; pulmonary fistula refractory to drainage; continuous intrathoracic bleeding (100 mL/h or 1000 mL after drainage); and hemodynamic instability refractory to IVR.[6,7] The patient's activities of daily living and social background are also comprehensively assessed. To accomplish the primary survey via computed tomography, it is essential that the patient's vital signs are stable.

In the current patient, a cardiac injury was suspected after the comprehensive assessment, and the patient had stable vital signs. Exploratory VATS was useful for simultaneously assessing and managing the patient's injuries and condition. Therefore, exploratory VATS may play a key role in the diagnosis and surgical management of a variety of high-energy chest traumas, including those with fatal injuries such as penetrating cardiac injuries.

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No funding was provided.

CONFLICT OF INTEREST STATEMENT
The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author. upon reasonable request.

ETHICS STATEMENT
Approval of the research protocol: N/A.
Informed consent: Informed consent was obtained from patient.
Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.

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