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Emergent surgery for cardiac herniation coexisting with complex blunt cardiac injury: A case report

Kazuki Mashiko^{*}, Hisashi Matsumoto, Hiroshi Yasumatsu, Taichiro Ueda, Mariko Yamamoto, Yutaka Funaki, Yasuko Toshimitsu

Shock & Trauma Center, Nippon Medical School Chiba Hokusoh Hospital, 1715 Kamagari, Inzai-city, Chiba 270-1694, Japan

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ABSTRACT

A 38-year-old man was pressed on his trunk by a heavy object weighing about 100 kg. The patient was in shock status on arrival to the hospital. Circular collapse progressed rapidly during contrast computed tomography (CT) scanning. CT images revealed exacerbation of the right lateral deviation of the heart that was earlier seen on X-ray imaging. Considering cardiac herniation based on CT findings, we immediately performed resuscitative thoracotomy and clamshell thoracotomy at the emergency department. Intraoperative findings showed a pericardial defect, and the heart had deviated to the right thoracic cavity. Immediate repositioning revealed a marked improvement in circulation. Full-thickness cardiac injury was observed in the anterior wall of the left ventricle; no active bleeding was observed. We performed temporary thoracic wall closure after cardiography for damage control. After admission to the intensive care unit, he presented with respiratory failure associated with pulmonary contusion. Therefore, veno-venous extracorporeal membrane oxygenation (V–V ECMO) was used from the 2nd to the 5th hospital day. After confirming no intra-thoracic events on the 6th hospital day, chest wall closure was performed. The patient subsequently developed heart failure and mitral regurgitation associated with papillary muscle rupture. On the 62nd hospital day, he underwent mitral annuloplasty at the cardiovascular surgery division; After rehabilitation till 152nd hospital day, he was discharged without any neurological abnormality. This was an extremely rare case with concomitant full-thickness myocardial injury, intracardiac injury, and cardiac herniation. Rapid resuscitative thoracotomy and damage control including V–V ECMO yielded good results. Retrospectively, cardiac herniation should have been suspected earlier basis this observation. Our report highlights that cardiac herniation should be considered in case of cardiac shadow aberrations in cases of blunt chest trauma, familiarity with condition and its characteristic imaging findings are critical for the doctor overseeing initial trauma treatment.

Background

Cardiac herniation presents with obstructive or cardiogenic shock because of the deviation of the heart from the ruptured pericardium into the thoracic cavity. Reports of cardiac herniation after trauma, particularly in the acute phase, are extremely rare given the poor initial recall of this condition owing to its rarity compounded with challenges in treating polytrauma and lack of time for

^{*} Corresponding author at: 9-36, Shima, Tsukuba-shi, Ibaraki 305-0833, Japan.
E-mail address: kmashiko@nms.ac.jp (K. Mashiko).

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detailed diagnosis because of rapid circulatory collapse.

We experienced a case of full-thickness left ventricular injury with cardiac herniation because of blunt trauma. As the patient showed characteristic findings on computed tomography (CT) imaging, we diagnosed this condition and achieved stabilization in the acute phase with rapid resuscitation surgery; however, acute respiratory failure became apparent, and veno-venous extracorporeal membrane oxygenation (V–V ECMO) management was required. Intracardiac injury was identified as the cause. To the best of our knowledge, no reports of patient survival in cases of cardiac herniation concomitant with full-thickness ventricular injury exist. Here, we present the clinical course and characteristic findings of our case.

Case presentation

A 38-year-old man suffered blunt chest trauma with an iron pallet (~100 kg). The ambulance dispatch center suspected severe trauma from the injury mechanism, and dispatched both an ambulance and physician staffed Helicopter Emergency Medical Services (HEMS) immediately.

Prehospital treatment

At 24 min from injury, approximately 50 km from the hospital, the HEMS doctors and nurse contacted the patient. Preliminary examination revealed tachypnoea, hypoxia, marked cold sweat, tachycardia, a pulse rate of 120 bpm, palpable radial artery, and an SpO₂ level of 86% under high-flow oxygen administration. He complained of chest pain; however, no chest sway or roaring sound was noted. Coarse crackles were heard in both lung fields. The initial focused assessment with sonography in trauma (FAST) result was negative. The patient was restless due to shock and hypoxia, and transported by the helicopter after sedation and tracheal intubation.

Initial management at ED

On arrival at the emergency department (ED), his heart rate was 127 bpm, blood pressure was 85/52 mmHg, and Glasgow Coma Scale (GCS) score was E1V1M1 (after sedation).

Portable chest X-ray imaging was performed during tube thoracostomy from the left to the right basis pre-hospitalization observations. Evaluation of the chest drainage specimen indicated arterial blood on the right and venous blood on the left. Radiography revealed a rightward deviation of the cardiac shadow and an infiltrative shadow in the left lung field that was suspected to be a lung contusion (Fig. 1). We started emergency blood transfusion and concluded that the circulation had not collapsed; hence, we performed a computed tomography (CT) scan.

Circulatory collapse progressed rapidly during CT imaging. Based on the scout view and CT image (Fig. 2), the rightward deviation of the cardiac shadow was suspected to be gradually progressing. Therefore, considering cardiac herniation, we decided to perform resuscitative thoracotomy at ED.

Surgical procedure and findings

At 80 min after arrival at the ED, we performed resuscitative thoracotomy with a left anterolateral incision between the 5th

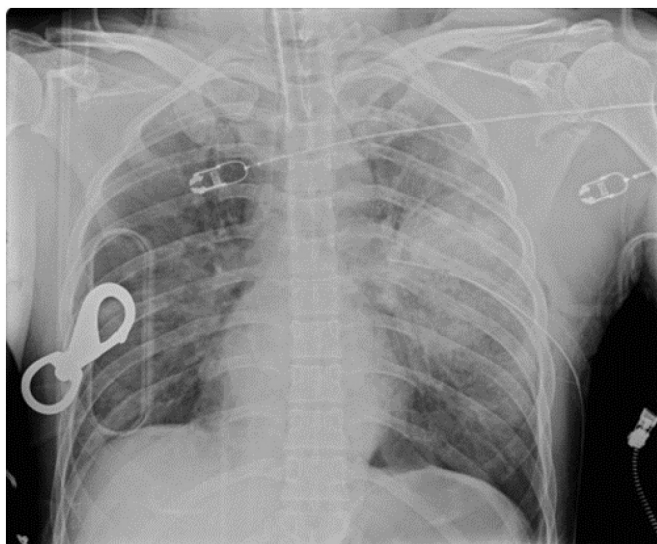


Fig. 1. Portable chest X-ray image on preliminary examination showed a rightward deviation of the cardiac shadow.



Fig. 2. Upper; Scout view of the CT scan showed progress of the deviation of the heart. Lower; Enhanced CT scan also showed progress of the heart deviation of the heart.

intercostal space. Intraoperative findings of the left thoracic cavity included venous bleeding immediately below the left lung contusion. The heart deviated to the right, and the expected location of the pericardium was empty. Immediately after a clamshell thoracotomy, the pericardium severely ruptured to the right thoracic cavity, and the heart had escaped the pericardial cavity and

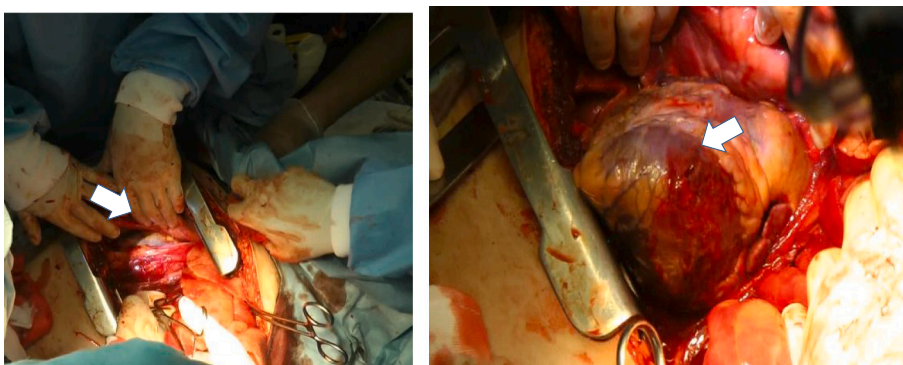


Fig. 3. Intraoperative findings. Lt: Clamshell thoracotomy revealed that the heart had deviated into the right thoracic cavity (arrow) from the large pericardium defect. Rt: When the pericardium was opened, haemodynamic stability was obtained promptly. Full-thickness injury was observed (arrow), and cardiorrhaphy was performed.

deviated toward the right and dorsally. When the cardiac sac was opened and the heart was reduced to the midline, the haemodynamics improved promptly. We concluded that the patient had obstructive shock because of cardiac herniation. A full-thickness injury of approximately 1 cm was observed on the anterior wall of the left ventricle. However, we did not observe any active bleeding then; we concluded that bleeding temporarily stopped because of decreased circulating blood volume and left ventricular volume (Fig. 3). We performed cardiorrhaphy using polypropylene sutures with pledgets; we also performed temporary chest wall closure using towel packing for damage control. The operation time was 29 min. The total blood transfusion volume during ED stay was 22 packed red blood cell units (3080 mL) and 24 fresh frozen plasma units (2880 mL). Diagnosis at this time was left ventricular injury with cardiac herniation, multiple rib fractures, bilateral lung contusion, and left shoulder fracture.

Postoperative course

The patient was transferred to the intensive care unit immediately after initial surgery at ED. Because hypoxia did not resolve even with ventilator management, we placed a venous drainage cannula into the inferior vena cava and a reinjection cannula into the left common jugular vein and introduced V–V ECMO on the second hospital day according to our ECMO protocol (Fig. 4). After confirming ECMO withdrawal on the 5th hospital day without any complications, routine chest closure was performed on the 6th hospital day. Subsequently, heart failure became more prominent after ventilator withdrawal, and ultrasound cardiography revealed mitral regurgitation due to papillary muscle rupture. This finding was consistent with the impact of trauma given his age and clinical course. Because management was challenging even with a combination of medical treatments, mitral annuloplasty and tricuspid annuloplasty were performed on the 62nd hospital day. The patient developed a surgical site infection that took a long time to resolve, and on the 152nd hospital day, he was transferred to the hospital without neurological abnormalities and cardiovascular complications for continued rehabilitation.

Discussion

Cardiac herniation is a rare condition and a well-known complication of major surgery in the lungs and mediastinum; however, reports of cardiac herniation due to blunt trauma are scarce [1–10]. Furthermore, in most reported cases symptoms appeared gradually after the injury, allowing sufficient time for the diagnosis of cardiac herniation; reports of severe circulatory insufficiency requiring resuscitative surgery, as in this case, are only fewer [8]. We hypothesise the following as causes. First, cardiac herniation often develops when a strong direct force is applied to the chest and abdomen that is likely to cause serious damage to surrounding organs and is fatal. Second, surgery might not have been performed in time because of the rapid progression of circulatory insufficiency. Third, rarity of this condition leads to poor initial clinical suspicion. Fourth, in some cases reported as “traumatic pericardial rupture”, it was not possible to determine that the hernia was the cause of the circulatory collapse. Our case is an extremely rare case of successful patient survival over cardiac herniation with full-thickness left ventricular injury and intracardiac injury treated with resuscitative thoracotomy, cardiac suturing, V–V ECMO, and intracardiac repair under a damage-control strategy. The extremely high fatality rate associated with haemothorax-type cardiac injury because of blunt trauma is considered the reason for the lack of reports in the literature. Only 1 case report on cardiac herniation with coexisting intracardiac valve injury after blunt trauma exists [5].

According to past reports, patients could develop a hernia while seated [1], and repositioning and movement have been associated



Fig. 4. Portable chest X-ray image when upon introducing V–V ECMO showed that the cardiac shadow had reduced to the midline under temporary chest wall closure.

with the risk of developing cardiac herniation. In our case, circulatory insufficiency progressed rapidly during CT imaging; release of positive pressure into the thoracic cavity because of tube thoracostomy and movement to the CT examination table could be the causes.

Pericardial tear often occurs in parallel across the left and right phrenic nerves [4], and onset site in our case was the same site on the right. Most intrathoracic ruptures (50%–76%) occur on the left [4]. In cases of both pericardium and diaphragm rupture, the likelihood of intra-abdominal organs entering the pericardial cavity is greater than that of the heart escaping it. Per past reports, cardiac herniation manifests different symptoms depending on the laterality of occurrence; right-sided hernias likely cause twisting of the inflow and outflow tracts and manifest a shock status. In contrast, left-sided hernias cause heart malposition but are less likely to manifest a serious shock [4], which could explain the relative abundance of reports of left-onset cases.

Emergent surgery is the only effective treatment, and thoracotomy was performed in most cases. Although reports of doctors electing to perform video-assisted thoracoscopic surgery in patients with stable circulation and in cases wherein a definitive diagnosis could not be obtained [4] exist, surgical positioning is an exacerbating factor. In this case, we performed resuscitative thoracotomy followed by clamshell thoracotomy. This surgical intervention helped in evaluating both the thoracic and pericardial cavities quickly while the patient was supine. Most pericardial deviations are considered to span 8–12 cm, and direct closure with nonabsorbable filaments is generally performed; however, patch closure is performed in case of complications such as pericardial edema [3,9].

Conclusion

Cardiac herniation is an extremely rare and fatal condition. Severe chest trauma presenting with shock is difficult to treat. However, with early diagnosis of this pathology, stabilization can be obtained relatively easily with prompt surgery. Therefore, familiarity with condition and its characteristic imaging findings are critical for the doctor overseeing initial trauma treatment. We believe the clinical course and imaging findings of our case would serve as a reference.

Ethics approval and consent to participate

Include a statement on ethics approval and consent.

Consent for publication

This Case report has obtained consent from the patient himself to use the progress and data related to medical treatment for academic purposes in accordance with the personal information protection guidelines. All data and medical information in this paper are stored in our medical records. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Authors' contributions

All authors read and approved the final manuscript.

Declaration of competing interest

The authors declare that they have no competing interests.

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