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Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Penetrating pulmonary vein laceration following blunt chest trauma

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ARTICLE INFO

Keywords:

Cardiothoracic
General surgery
Intensive care
Orthopaedics
Shock

ABSTRACT

Flail chest is a common injury in blunt trauma which is usually treated with analgesia, oxygen, and other conservative measures. In more severe cases mechanical ventilation and surgical stabilization of rib fractures (SSRF) may be warranted. Penetrating injury to the heart or great vessels due to rib fractures however, is much less common. Here we present a 33 year old male that was admitted to the Emergency department (ED) after a horse riding accident, demonstrating severe shock. Emergency computerized tomography scan showed multiple bilateral displaced rib fractures, Left hemothorax and possibly a penetrating injury to the left side of the heart by one of the ribs. Notably, no significant pericardial effusion was demonstrated. In addition, a grade V splenic injury was diagnosed. A Joined thoracic and abdominal emergent surgical treatment was successfully carried out and the patient survived and fully recovered.

Case presentation

A 33-year-old male without significant medical history was admitted to the ED after a horseback riding accident, with agitation and tachycardia as first signs of shock (Glasgow Coma Scale (GCS) – 10 agitated, Pulse – sinus 110_{bpm} Blood pressure 160/100_{mmHg}, oxygen saturation 94% (nasal cannula- 5Liter oxygen flow). Physical examination revealed multiple chest and abdomen contusions.

Focused Abdominal Sonogram for Trauma (FAST) demonstrated free fluid in the Morison's pouch. Initial cardiac and thoracic sonographic evaluation did not identify a pericardial nor pleural effusion. Chest X-ray demonstrated bilateral rib fractures and multiple free fragments in the left side of the chest (Fig. 1A). One fragment even appeared in contact with the heart's silhouette.

During the above evaluation in the ED trauma room, his level of consciousness began to deteriorate (Glasgow Coma Scale- 8) without hemodynamic changes.

The patient was taken immediately (23 min from admission) to total body CT angiography (CTA) placed adjacent the ED trauma room before transferring to operation room.

This study demonstrated bilateral displaced multiple ribs fractures with a left sided flail segment. The 5th rib's edge was penetrating the lung parenchyma and pericardium. In addition, left hemo-pneumothorax, large right pneumothorax and a grade V shattered spleen

Abbreviations: SSRF, Surgical stabilization of rib fractures; ED, Emergency department; FAST, Focused abdominal sonogram for trauma.

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<https://doi.org/10.1016/j.tcr.2021.100596>

Accepted 18 December 2021

Available online 23 December 2021

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with active arterial bleeding and significant amount of hemoperitoneum were evident (Fig. 1B, C). Diagnosis of cardiac trauma by rib penetration could not be excluded but no pericardial effusion was shown.

Direct from the CTA examination, the patient was taken to the operating room (OR) for emergency chest and abdominal exploration (44 min from admission). Bilateral chest tubes were inserted. Simultaneously midline laparotomy and left thoracotomy were performed. Urgent splenectomy and completion of the abdominal exploration were done by the general trauma surgeons while in the same time the cardiothoracic surgeons performed a pericardial window which revealed the diagnosis of bloody pericardial effusion. The tip of the broken rib lacerated the posterior part of the heart. It was very difficult to identify the location of the laceration through the thoracotomy, so the broken rib was left in its position and mid-sternotomy was made for better control and further management.

Cardiac evaluation revealed an 8 mm laceration of the superior left pulmonary vein, done by the penetrating 5th rib. The laceration was repaired by a “figure of eight” 4–0 prolene suture that managed to stop the bleeding. It was very difficult to identify the injury due to the location of the laceration, severe hypovolemia and the pressure caused by the rib.

At that stage, the patient was in a significant hypovolemic shock state due to the significant blood loss (both from the chest and abdomen). In order to achieve adequate and rapid volume resuscitation, a high flow line was inserted directly to the right atrium and a massive blood transfusion was administered (6 units packed cells, 10 units platelets and 2 units fresh frozen plasma). Immediately afterwards cardiopulmonary resuscitation (CPR) was started due to ventricular fibrillation including open cardiac massage, administration of intravenous Adrenaline, Amiodarone and internal defibrillation. Blood gases examination revealed significant hyperkalemia ($K = 7.8$ meq/L) most probably because of massive cold blood transfusion, the hyperkalemia was treated medically and eventually return to spontaneous circulation (ROS).

After the patient was hemodynamically stable, both sternum and abdomen were closed as a damage control procedure for continuous oozing and the patient was transferred to the general intensive care unit (G-ICU).

In the following days, the patient underwent 2 s stage operations- left chest closure with left sided SSRF (Fig. 3) and an open reduction and internal fixation of a proximal tibia fracture that was diagnosed during secondary survey in the GICU. The patient underwent a successful extubation a week after his admission to the hospital. The patient was discharged back home two weeks later in an excellent condition.

Discussion

Blunt chest trauma, especially including flail chest, obligate a prudent and constant evaluation. Usually, the mechanism of heart injury in blunt trauma is sudden change of pressures applied to the heart, It has a tenuous, although potentially fatal possibility of tamponade due to internal penetrating cardiac injury. Associated injuries to flail chest have shown to a major role in the outcome of patients with blunt trauma [1]. Blunt cardiac Injuries occur in up to 76% of patients with severe thoracic or multiple injuries, and left sided cardiac lesions are significantly less frequent (about of one third) [2].

Both median sternotomy and left anterior thoracotomy (LAT) are acceptable surgical approaches for acute treatment of cardiac injury. The CTA in this case suggested a left sided thoracic injury with suspected cardiac penetration (Fig. 2). Hence, we chose to do LAT for completion of the diagnosis (tamponade versus non tamponade) and as a primary damage control. Given the patient's hemodynamic deterioration and the unusual location of the heart penetration point, we continued with a median sternotomy for better exposure and access, as we already thought about the worst case scenario of connecting the patient to a cardiopulmonary bypass machine in order to be access the left superior pulmonary vein. Median sternotomy is the main approach in more stable patients [3]. In this case, however, it allowed us to address the penetration site very conveniently and very quickly, along with direct cardiac resuscitation and blood transfusion directly to the right atrium.

About two thirds of abdominal traumas have a concomitant chest injury. Treatment priorities are dictated first by the life threatening injuries followed by those with the highest risk to develop into worsening injuries. Although published series are small and retrospective, it is likely that laparotomy should precede thoracotomy in patients with combined injuries [4], Skilled and well-

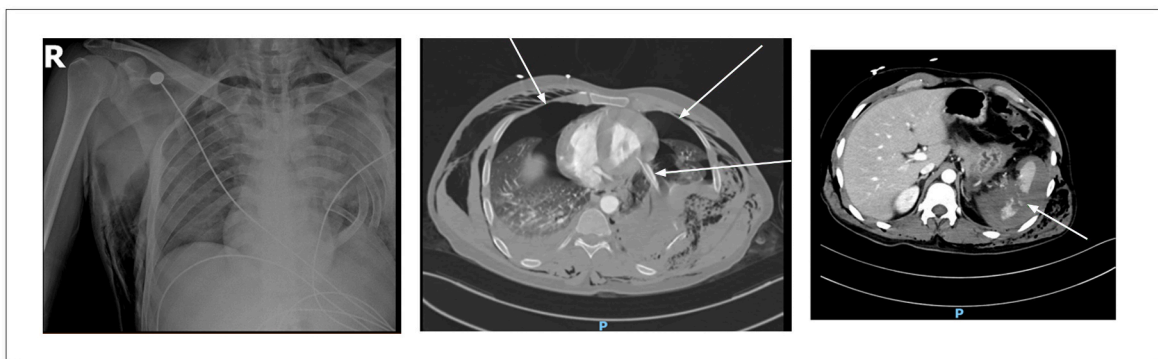


Fig. 1. A- CXR - Lt side flail chest; B- CT -bilateral pneumothorax (white arrows) and left hemothorax with the edge of the left 5th rib penetrating into the pericardium (green arrow); C- CT- 5th grade splenic injury.

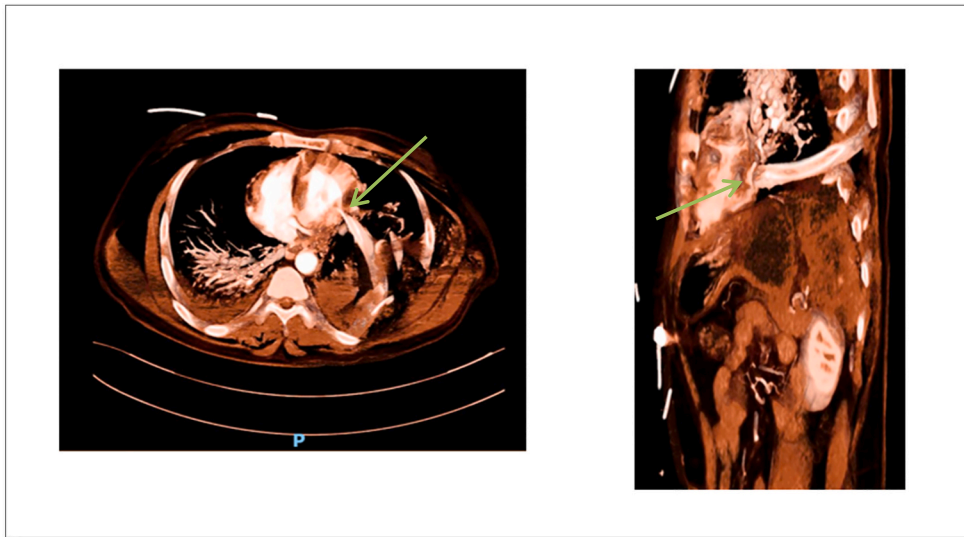


Fig. 2. CTA showing Flail chest and 5th rib puncturing the left side of the heart (green arrow) A and B - horizontal and left parasagittal planes respectively.

coordinated trauma teams can manage such challenging scenarios in parallel.

SSRF for a traumatic flail chest is associated with significant clinical benefits [5]. Although flail chest is an uncommon finding in blunt trauma, early rib fixation has major clinical benefits regarding morbidity and mortality [6]. Although SSRF can sometimes be done as an emergent procedure as part of the initial damage control surgery, it is usually carried out, like in our case, as part of the second look trauma surgery, preferably within 72 h of the initial injury, after the patient's hemodynamic status stabilized enough. We took the patient back to the OR after 24 h for this 2nd stage surgery, mainly because he was stable enough, removed the packing and fixed the broken ribs using the MATRIX-RIB fixation system (De-Puy Synthes Inc.) (Fig. 3). Although the patient suffered a massive lung contusion, he was weaned off the mechanical ventilation uneventfully 6 days after the first operation.

Conclusion

The vast majority of blunt cardiac traumas are benign and in the absence of cardiac tamponade, diagnosis of heart damage can be challenging. However cardiac puncture caused by a rib fragments should be suspected and addressed for further evaluation and

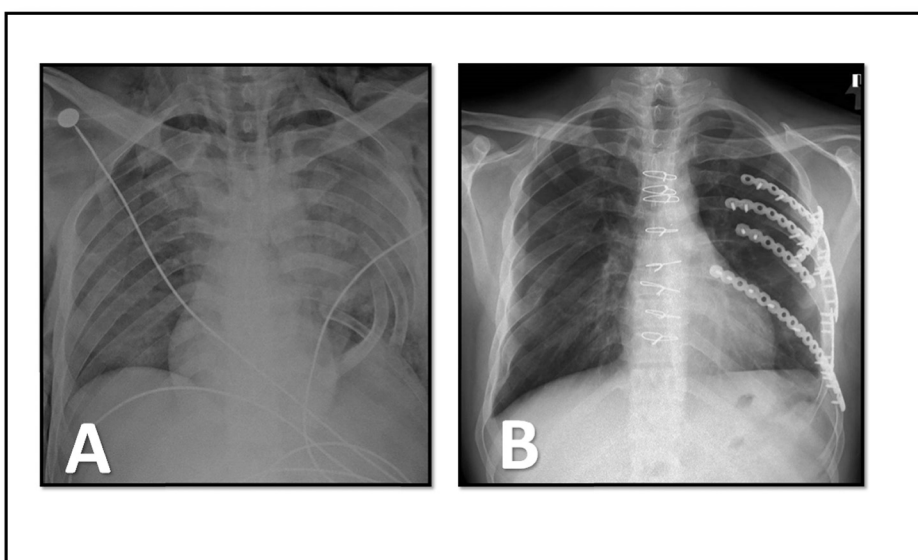


Fig. 3. CXR – A pre and B post left sided SSRF respectively.

treatment in a severe blunt chest trauma. A multidisciplinary approach is essential involving cardiac surgeon and using a mid-sternotomy incision may be the recommended approach for complicated heart and great vessels injuries.

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