Penetrating Thoracoabdominal Injuries from an Iron Fence: Case Report and Literature Review

**Abstract:** Penetrating injuries through the abdomen and thorax have a higher impact on morbidity and mortality than injuries inside one of them. Resuscitation and Handling properly in early stages will bring good results to the patient.

**Keywords:** injuries, thoracotomy, laparotomy, penetrating, iron fence, thorax-abdominal, liver.

**INTRODUCTION**

Penetrating injuries through the abdomen and thorax have a higher impact on morbidity and mortality than injuries inside one of them. Foreign objects that enter the body cavities should not be detached prior the patient’s arrival in the operating room (Muchuweti, D., & Muguti, E. 2020). Trauma is the third most prevalent cause of mortality after cardiovascular disease and cancer and the leading cause of mortality in patients under 40 years old (Petrowsky, H. et al., 2012). Injury of the abdomen is an usual cause of death, accounting for 7-10% of trauma patients. The condition will depend on injured organs and hemodynamic stability (Johnson, J. J. et al., 2013). Presentation of penetrating abdominal and chest trauma can provide clinical features of pneumomediastinum, hemothorax, cardiac tamponade, pneumothorax, airway obstruction, and pulmonary contusion (Shannuganathan, K., & Matsumoto, J. 2006).

Penetrating abdominal injuries can be extended to the intrathoracic organ, which may present with massive hemoperitoneum due to the mesentery injury, gaster, spleen, liver, or peritonitis from bowel perforations. Abdominal stab wounds usually affect hollow vissus organs (Biff, W. L., & Moore, E. E. 2010). Foreign bodies that stab intraabdominal or chest have a tampon effect, and attempts to remove them before surgery increase the severity and risk of death. (McDonald, A. A. et al., 2018).

A total of 1359 patients from 2004 study with traumatic injury of the chest at a United States level I trauma center figured that only 18% of patients needed tube thoracostomy and 2.6% required advanced thoracotomy (Shannuganathan, K., & Matsumoto, J. 2006). The severe injury cases happened from blunt trauma, and the overall death was 9.45%. Immediate thoracotomy and laparotomy are essential for managing double cavity injuries and retrieving foreign materials (DeBarros, M., & Martin, M. J. 2015).

**ILLUSTRATION**

Four hours before admission to the hospital, while a 24 years old Mr. H was repairing the roof of the house by climbing over the fence, the patient suddenly lost his balance and then slipped from the roof. The patient fell with his chest position of the lower right abdomen stuck at the end of the open gate in a standing position. The others were released by lifting the patient's body from the bottom up. After being released from the entrance, one end of the fence was broken and allegedly left inside the patient's body. After the incident, the patient complained of abdominal and chest pain. The patient was immediately taken to Sukoharjo District Hospital by rescue workers, put on IV lines, stitched up the wound, injected with analgetic, and did a chest X-ray. Parts of the iron fence were left in the stomach and chest. Because of this condition, the patient must get an assessment and intervention of the thoracic and digestive in Dr. Moewardi Surakarta Hospital.

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The patient was a healthy young male with stable hemodynamic. No sign of anemia and cyanosis in mucous membranes were found. His blood pressure was 130/80 mmHg, pulse was 108 beats per minute, and respiratory rate was 28 breaths per minute. Oxygen saturation level on free air was 94%. Chest examination showed breathing from the left chest was higher than the right one. The laceration was sutured with 3.0 nonabsorbable multifilament thread at midaxillary line sixth intercostal and abdominal above the right inguinal line. Physical examination revealed lacerations in the chest and lower right abdomen. On percussion, lung sounds dim at the level of 5-8 ribs.

![Figure 1. Picture of patient in the emergency room before operating surgery (a) front view and (b) right side view](image)

The patient was given oxygen 10 liters per minute with a non-rebreathing mask, ringer lactate infusion, human tetanus immunoglobulin injection 250 UI, and ampicillin injection 1 g every 8 hours. Breathing clearance with chest tube placement on the right chest was performed, produced 300 ml of blood. Before entering the operation room, the blood production rate was 200 ml per hour. A nasogastric tube (NGT) was inserted to drained the bleeding and removed exaggerated gas from the intra-abdominal cavity. A transurethral catheter was placed for urine output measurement. Complete blood count, blood glucose, FAST, X-ray of the thorax and abdomen were done. Laboratory results showed low hemoglobin level (9.5 g/dL), elevated white blood cells (18.2 × 10³ Cells/L), segmental neutrophil 88.7%, and elevated liver enzyme (SGOT 391 U/L). The blood gas analysis found pH: 7.565, BE: 3.6 mmol/L, PO2: 76.6 mmHg, and lactate serum increased to 2.5 mmol/L. Minimal hemorrhage in Morrison pouch was found during FAST examination. There was also probe tenderness in the epigastric and the right hypochondriacal to the right lumbar region. X-ray examination showed that a foreign body penetrating the lungs and damage to organs in the abdomen couldn't be evaluated. We managed the case with open surgery.

![Figure 2. Chest x-ray before and after chest tube insertion](image)

Thoracotomy and laparotomy were done simultaneously with caution on the emergency area that must be managed first. The foreign object, the green iron fence, damaged the right pleura and penetrated the diaphragm. The patient laid in the left lateral decubitus position and was sedated with general anesthesia. The
operation began with an aseptic procedure, and then a 15 cm long incision was made on the 6th ICS at the posterolateral region, deepened to the intercostal muscle. The incision was made above the right sixth rib, anterior to the midaxillary line. Serratus anterior muscle was preserved by cutting the fascia on the posterior side. Elevation of the scapula was performed. The sixth ICS was identified by palpating the ribs under the scapula (the second ribs at the most prominent part). One lung procedure was completed and the right lung was deflated. Dissection above the seventh rib was performed, opened the parietal pleura. A blood clot was discovered in the pleural cavity. The foreign object went through the medial side of the diaphragm with the tip attached to the pericardium. It was pushed towards the diaphragm. The diaphragm perforation (diameter 2 cm) was repaired with a simple interrupted 4.0 nonabsorbable monofilament thread. Chest tube thoracotomy no.28 was inserted into the pleural cavity, then connected to a single bottle WSD. The production of WSD was 300 ml of blood from the right pleural cavity, which was suction out. The chest tube fixated with lived knots.

Figure 3. Exploratory Thoracotomy procedure followed by insertion of a chest tube

Laparotomy was done in a supine position under general anesthesia. Midline incision 2 cm below the xiphoid process of the sternum was made, followed by dissecting along 20 cm the abdominal wall layer by layer until the peritoneum was found. The ripped from the peritoneum was 3 cm as high as the 12th ribs. The stomach, spleen, jejunum, ileum, and colon were identified in good condition. Blood clots and bleeding were found under the liver, and then the evacuation procedure was performed. Green iron fierce was penetrated the liver in VIII zones. Extraction of the foreign material was carried out, obtained metal with a conical shape, 15 cm of length and 5 cm of diameter. Hepatic rupture grade IV was found, and the bleeding was controlled using a pringle maneuver for the time being. The liver was pressed with gauze. After 15 minutes of evaluation, the edge of the torn liver was covered with an absorbable collagen sponge. The operator washed the abdominal cavity, prepared a drainage tube, and sutured the peritoneum and fascia. A peritoneal tube was installed in the right abdomen equal to the umbilical. Continues suture was performed at the peritoneum and fascia with multifilament nonabsorbable thread no 1. The subcutis was sutured with simple interrupted using 2.0 multifilament absorbable thread. Then the cutis was stitched with a simple interrupted using 3.0 nonabsorbable multifilament suture.

The wound in the right inguinal from the previous hospital was opened. There is an irregular edge, subcutis base, 10cm long, contaminants (+) iron rust + peeling paint wound. Debridement was conducted using H2O2 and betadine then washed with 0.9% NaCl infuse until clean. The subcutis was closed with a simple interrupted 2.0 multifilament absorbable thread. At the last step, the cutis was done with a simple interrupted 3.0 nonabsorbable multifilament suture. Four bags of packed red cells and four bags of whole blood were fulfilled during the operation due to active bleeding. The total estimated blood loss from the procedure was 800 ml.
Figure 4. Laparotomy exploration procedure followed by foreign body disposal and insert abdominal tube drainage

Postoperative routine hematology was carried out, resulting in abnormal leukocytes (15.1 x 10³). Chest imaging demonstrated a lung contusion. The patient was admitted to the ICU for recovery. Vital signs, urine output, routine blood laboratory, drainage product from both chest and abdomen tube measured every day. On the first day, the chest and abdominal drainage produced 50 ml and 200 ml sero-hemorrhage. After one day of treatment in the ICU, leukocytes measurement came back with normal value. On the third day postoperative, the drainage production was stopped from the chest drainage, while the drain from the abdominal tube still produced 400 ml of bile.

The patient went to the standard care room. A PA chest X-ray was conducted before the transfer to the standard care room. The result showed a pulmonary contusion, and then the chest drainage was removed. The patient was discharged after seven days of hospitalization. The abdominal drainage was persisted with an average production of 50 ml per 24 hours. The liver function enzymes were elevated (SGOT 104 and SGPT 143). On the 12th day after the operation, a follow-up was carried out with the patient's general condition was good, the wound was clean, and there were no signs of inflammation. Because the abdominal drainage was not producing any secretes, it was removed. Abdominal ultrasound was performed, which resulted in a normal abdomen. The routine blood and liver function test were back to the normal level.

**DISCUSSION**

Penetrating trauma in the thorax-abdominal region may lead to complicated and life-threatening conditions (Shanmuganathan, K., & Matsumoto, J. 2006). Several causes, such as high kinetic energy with large-caliber firearms and low kinetic energy of stab wounds, can result in penetrating injuries. Patients with stabbing abdominal trauma should be evaluate signs of organ failure, pneumothorax, and peritonitis based on physical examination, laboratory, and radiology, including ultrasound, CT scan, MRI, or X-rays (Hanna, W. C., & Ferri, L. E. 2009).

Airway, breathing, and circulation disorders that require immediate treatment can occur due to penetrating trauma in the thorax-abdominal region. Massive hemothorax or penetrating thoracic trauma in poor condition should undergo resuscitative thoracotomy (Sawhney, C. et al., 2009). Initial radiology examinations such as an x-ray of the chest and focused abdominal sonographic examination for trauma (FAST) may discover the accumulation of the blood, both in the abdominal and peritoneal cavity, also in the pericardial sac (Petrovsky, H. et al., 2012; & Kim, K. T., & Seo, P. W. 2016). Insertion of a tube into the pleural cavity to drain air, blood, bile, pus, or other fluids is called tube thoracostomy. Thoracostomy or thoracoscopic procedure is indicated when the mediastinum blood clot evacuation and hemorrhage control are not achieved. Thoracotomy is indicated when a large volume of bleeding (>1.500 mL) or continued hemorrhage (>200 mL/hour) is present (Chen, C. Y. et al., 2010; Troxler, Max. 2016; & Biffl, W. L., & Moore, E. E. 2010).

From this case, we found that the patient had shortness of breath caused by a hematotherax on the right side with ongoing bleeding. A negative FAST examination showed no damage, but a green iron fence on the abdominal wall that penetrated the lung diaphragm was shown on the x-ray findings. Following the guidelines from the 2014 World Journal of Surgery, the examination was continued with thoracoscopy (Thiam, O. et al., 2016). If there is a rupture of the diaphragm, then a thoracostomy should be performed, followed by a laparotomy.
Urgent thoracotomy is needed in the emergency of hemothorax. Emergency management should consider many factors, including indications, clinical conditions, trauma mechanism, and imaging findings. The requirement for urgent thoracotomy was made based on ATLS protocol (chest drainage product >1500 ml initial or >200 ml/day, large un-evacuated clotted hemothorax which can cause shortness of breath that leads to life-threatening conditions and risk for cardiac tamponade, massive air leak, incomplete lung expansion, significant chest wall defect, injury of the major vessel, esophageal, diaphragm, and cardiac (Mahoozi, H. R. et al., 2016). Delayed thoracotomy in chest injury results in late empyema, fibrothorax, and other morbidities. Abdominal sonography and chest X-rays in thoracic injury should be accomplished routinely, including in these patients (Mahoozi, H. R. et al., 2016; & Mock, C. (Ed.). 2004).

Proper placement of chest tube on hemothorax case will remove excess fluid from the pleural cavity. The tube must be in the midaxillary line or posteriorly of the anterior lateral line in a supine position, generally placed in the sixth or seventh intercostal space. To prevent blood clot obstruction, larger-diameter tubes have been used for suspected hemothorax cases (Chen, C. Y. et al., 2010; Mahoozi, H. R. et al., 2016; & Broderick, S., & Hemothorax, R. 2013). Newly prospective analysis of chest tube size compared size 28F to 32F tubes with 36F to 40F tubes in 293 patients at a level I trauma center. The results discovered no difference in the outcomes for previously placed chest tubes. Chest tubes removal was considered when the drainage production is less than 150 ml/24 hours (Muchuweti, D., & Muguti, E. 2020; & Mahoozi, H. R. et al., 2016).
The right thoracoabdominal incision has been reported by Kim and Seo to gain access to the bleeding source and treat injuries caused by a steel bar penetrating the abdomen (Kim, K. T., & Seo, P. W. 2016). We gained access by performing simultaneous thoracotomy followed by laparotomy. By widening the operating area, the attempt to control bleeding became easier. The definitive therapy for organ injury management based on the severity of the injuries. From this case, the hemothorax is caused by a direct laceration to the chest blood vessels. Trauma to the lung parenchymal from the thoracic wall penetration is common and mostly self-limiting, although the injury can result in occult hemopneumothorax. Chest imaging and blood gas analysis were done during the patient ICU admission to detect early complications and further damage of the pulmonary parenchymal tissue. In this patient, after the 12th day of postoperative control, there was no sign of hemopneumothorax (Muchuweti, D., & Muguti, E. 2020; & Kim, K. T., & Seo, P. W. 2016).

One of the causes of death in severe abdominal injury is liver damage. It is responsible for 10% to 15% mortality. The American Association for the Surgery of Trauma (AAST) divided the severity of liver injuries into six grading scales. Most patients admitted for liver injuries have grade I, II, or III, and nonoperative management are successfully treated. In contrast, almost two-thirds of grade IV or V injuries require laparotomy. In this case, the laceration of the liver is more than 30% of the hepatic lobe. According to the AAST liver trauma classification, this indicates a grade IV liver injury that requires laparotomy (Todd, S. R. 2004). Intensive resuscitation during operation with early institution of a massive transfusion protocol is needed to preserve organ perfusion and reverse all trauma-induced physiological derangements.

The WSES position paper classified traumatic hepatic lesions into minor (grade I, II), moderate (grade III), and major/severe (grade IV, V, VI). A laparotomy surgery was performed based on the patient’s clinical condition. Patients with high-grade lesions (i.e., grade IV-V laceration with parenchymal disruption involving more than 75% of the hepatic lobe or more than 3 Couinaud segments within a single lobe) may treat nonoperatively if the hemodynamic is stable. On the other hand, “minor” lesions may need immediate surgery when the patient arrives with hemodynamic instability. Unstable conditions are described by the systolic, mean arterial pressure < 65 mmHg dan blood pressure < 90 mmHg with clinical evidence of shock with skin vasoconstriction (cool, clammy, decreased capillary refill). Decrease level of consciousness and/or shortness of breath, or > 90 mmHg but requiring infusions/transfusions and/or vasopressor drugs and/or admission base excess (BE) > -5 mmol/l or transfusion requirement of at least > 4 units of packed red blood cells within the first eight hours (Coccolini, F. et al., 2016).

Based on the vital sign from this case, this patient was in stable condition, but the ongoing bleeding could be a life-threatening condition; thus, immediate laparotomy should be performed. Based on WSES classification, the patient had severe hepatic injuries WSES grade III includes AAST-OIS grade IV–V hemodynamically stable (Coccolini, F. et al., 2016). The Pringle maneuver is a surgical technique for abdominal operations that the hepatoduodenal ligament is clamped with a surgical tool or by hand for a short time. This maneuver is used during liver surgery to reduce blood loss for a short duration. In this case, using the Pringle maneuver followed by suturing the wound and giving blood transfusions helped stabilize the situation (Broderick, S., & Hemothorax, R. 2013; & Coccolini, F. et al., 2016).

**Conclusion**

Management of thorax-abdominal trauma needs contribution from a multidisciplinary discipline of the medical team. A stab of the thoracoabdominal region is associated with damage of organs, high morbidity, and mortality. Life-threatening conditions require immediate and appropriate thoracotomy and laparostomy procedures to save the patient and prevent long-term complications can be prevented early. The best treatment approaches are made base on the clinical condition, grade of injury, and the associated injuries.

**References**


