



Sternotomy or Thoracotomy: Which One?

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Abstract: Penetrating injuries to the chest present a frequent and challenging problems. Median sternotomy and thoracotomy are two choices to explore any trauma to the chest. We report a 37-year-old man with wound and pain in his left chest due to being stabbed with a knife one hour ago. On physical examination, an open wound measured 5x1.5 cm as high as the third rib parallel to the left parasternal line, the edges of the wound bed were flattened by the periosteum. Laboratory examination showed leukocytosis. FAST showed an important left pleural effusion and pericardial fluid. CTA study showed the presence of air in the anterior mediastinum and the left pleural cavity. In the fifth intercostal space, a left anterolateral thoracotomy was performed and 800 ml of blood was evacuated from the left chest. The left lung was lowered to open the pericardium, which caused a further drop in blood pressure; then, the pericardium was opened and a blood clot (1500 ml) was removed. An epicardial wounds were found on the anterior surface of the right ventricle. The left anterior coronary artery was actively bleeding. The hemorrhagic lesion was stitched with 4.0 polypropylene reinforced with a Teflon strip. The patient recovered uneventfully on the sixth postoperative day. During the 14-month follow-up, the patient was fine and back to work. In conclusion, surgeon must be able to decide the technique of approach in the operating room considering the site of injury and the presence of involving organ. Thoracotomy patient can also receive median sternotomy if the cardiac injuries could not be repaired through thoracotomy. In addition, some patients with median sternotomy also received additional thoracotomy due to their pulmonary injuries.

Keywords: penetrating injuries; thoracotomy; sternotomy; cardiac injury

INTRODUCTION

Penetrating heart injury (PCI) is considered a major surgical challenge for trauma teams due to its high mortality rate of 40% to 84%. Penetrating chest trauma can be accompanied by a variety of injuries ranging from superficial injuries to hemodynamic instability that requires immediate life-saving intervention.¹

Although translucent chest trauma is more fatal than blunt trauma, most penetrating injuries do not require major surgical intervention, and many patients are treated by serial observation and evaluation, while some only require a thoracotomy. About 15 to 30 percent of penetrating chest injuries require surgery, compared to less than 10 percent of injuries due to blunt chest trauma.²

The surgical approach to PCI is determined by the mechanism of injury, the location(s) of the wounds, and expected injuries. While median sternotomy is technically more difficult to perform and is associated with higher rates of wound complications than anterolateral thoracotomy, it provides excellent access to anterior mediastinal structures.³ Anterolateral thoracotomy through the fourth or fifth intercostal space provides limited access to the aortic arch, but it is relatively easier to perform because it provides urgent access to the chest cavity. We present the case of a patient with a puncture wound in the left parasternal, who was reported as injury to the right ventricle.⁴

CASE REPORT

A 37-year-old man was taken to the emergency room with wounds and pain in his left chest because he was stabbed with a knife an hour ago. The size of the knife was 15x4cm. On physical examination, the wound was open and measured 5x1.5 cm as high as the third rib parallel to the left parasternal line, the edges of the wound bed were flattened by the periosteum. Focused assessment with sonography for trauma (FAST) showed an important left pleural effusion and pericardial fluid; arterial systolic blood pressure was 100 mmHg and heart rate 110/min. Laboratory examination showed leukocytosis.

The patient was diaphoretic, tachypneic, and tachycardic (heart rate 105/min); systolic blood pressure was 80-90 mmHg, no venous stretching was observed. Volume replacement with 1500 ml crystalloids led to some improvement in systolic blood pressure. Taking into account the relative hemodynamic stability after volume replacement, it was decided to proceed with the computed tomography angiography (CTA) study, which, in addition to the known pleural and pericardial effusion, showed the presence of air in the anterior mediastinum and the left pleural cavity (Fig. 2). After CTA, systolic blood pressure dropped again to 60-70 mmHg, and the patient was immediately operated on.



Figure 1. Knife stab wound in a 37-year-old man

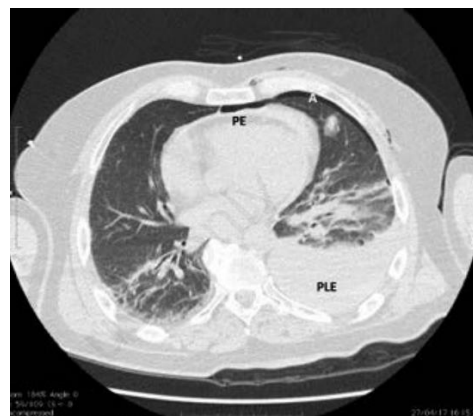


Figure 2. Chest CT scan showing pericardial effusion (PE), a huge left pleural effusion (PLE) and air (A) in the anterior mediastinum and anteriorly in the left pleural cavity

In the fifth intercostal space, a left anterolateral thoracotomy was performed and 800 ml of blood was evacuated from the left chest; The left lung was lowered to open the pericardium, which caused a further drop in blood pressure. Then the pericardium was opened and a blood clot (1500 ml) was removed. An epicardial wounds were found on the anterior surface of the right ventricle, one of which was 1 cm next to it. The left anterior coronary artery was actively bleeding. The hemorrhagic lesion was stitched with 4.0 polypropylene reinforced with a Teflon strip. The patient recovered uneventfully on the sixth postoperative day. During the 14-month follow-up, the patient was fine and back to work.

DISCUSSION

Large and life-threatening chest injuries can be remembered by a deadly dozen. The first six are fatal and require immediate evaluation and treatment during primary research: airway obstruction, pneumothorax tension, cardiac tamponade, open pneumothorax, massive hemothorax, and flabby chest. The other six are hidden: thoracic aortic disorder, tracheobronchial disorder, myocardial contusion, traumatic diaphragmatic tear, esophageal disorder, and lung tissue contusion. The hidden six are potentially life-threatening injuries and are usually diagnosed at a later trial.⁵

Thoracic injuries should be organized in four groups according to the topographic location of the wound or trajectory of the knife or rocket: 1) the base of the neck in the mediastinum or pleural cavity; 2) one pleural cavity in the mediastinum or spinal cord; 3) parasternal wound; 4) two lateral chest wounds involving both the pleural cavity and the mediastinum (usually caused by a gunshot shot). It is very important not to assume a straight line of projectile trajectory because surface injuries often do not correspond to the trajectory of the projectile. This consideration also applied to our case where left hemithorax injuries determined damage to the right ventricle. Projects of common interest are present in about 6.4% of all penetrating chest injuries and are considered a real challenge in Emergency Department due to their unpredictable clinical course and the need for urgent diagnosis and emergency care. For this reason, a heart injury should be immediately suspected in any patient with penetrating chest trauma.³

Given that the diaphragm is a moving goal, an injury that at first glance may seem abdominal, can actually be intrathoracic and vice versa. A physical examination in a patient showing external wounds to the chest can help find markers for possible internal injuries. High suspicion of heart injuries is necessary when the wound appears inside the so-called heart box (Figure 4), a region superiorly delimited by a strict notch, lateral nipples, and an inferior trans-pyloric line (cross line halfway between the xiphoid process and the umbilicus). The clinical presentation of PCI can range from hemodynamic compensatory stability to instability and cardiopulmonary stasis and can be associated with several factors, including the mechanism of wounding, the time elapsed before arriving at the trauma center, and the extent of the injury.⁶

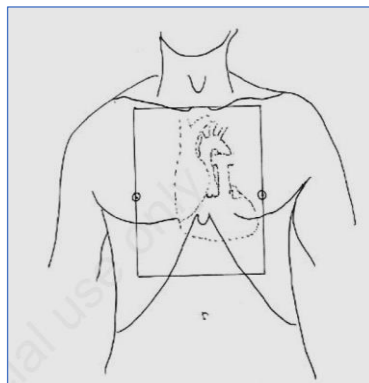


Figure 4. The cardiac box: the area is delimited superiorly by the sternal notch, laterally by the nipples and inferiorly by a transverse line halfway between the xiphoid process and the umbilicus⁶

The muscular nature of the left ventricle and, to a lesser extent, the right ventricle can close the penetrating injuries of the myocardium and prevent extant hemorrhages, allowing some patients to reach the emergency center in a hemodynamically stable way, sometimes with a deceptive clinical presentation. Most patients with PCI are unstable, and many arrive in the emergency department, receiving cardiopulmonary resuscitation. If the PCI is extensive, the injury always causes extant bleeding into the left hemithoracic cavity, and the patient develops cardiopulmonary arrest. Approximately 80–90% of patients with stab wounds in the heart experience signs of tamponade. Nevertheless, the Beck triad (muffled heart tones, jugular venous distention, and hypotension) and the Kussmaul sign (jugular venous swelling upon inspiration) represent the exception rather than the rule, which occur only in about 10% of patients with PCI.⁷

Although pericardial tamponade can have a protective effect by preventing massive hemothorax, it can also be a harbinger of shock, as it reduces ventricular filling, stroke volume and cardiac output.⁵ A mild to moderate amount of cardiac tamponade can be temporarily overcome by rapid fluid administration, which increases the preload and cardiac output, waiting for the final surgical treatment. Needle pericardiocentesis has limited benefits in the diagnosis and inversion of tamponade. The penetration of the needle into the heart chamber can determine a false positive result, while a false negative (up to 80% in some series) can be caused by blood clotting in the pericardial cavity. This maneuver retains a role only when a surgeon or operating room is not available, because the unpacking procedure can save time to take the patient to surgery or a trauma center.⁸

Median sternotomy should be considered as an incision of choice in emergency cases for resuscitation purposes, where penetrating trauma in the heart box can determine damage to the heart or large vessels. In our case, the presence of a huge left pleural effusion prompted the thoracic surgeon to choose the left anterior surgical approach, assuming that this may be the most important lesion. This approach determined the optimal left lung exposure. However, when the pericardium was opened and the right ventricular lesion was confirmed, cardiac exposure was much more difficult to achieve. Indeed, a midline sternotomy would have resulted in a much simpler surgical procedure.⁹

In patients without a pulse who present signs of life to the emergency department after penetrating a chest injury, some authors strongly recommend emergency department thoracotomy (EDT). These EDT recommendations are based on moderate-quality evidence for patients who are in cardiac arrest but have previously witnessed cardiac activity or who have unresponsive hypotension (BP < 70 mmHg) despite appropriate resuscitation.² This procedure requires left anterolateral thoracotomy in the supine position in the emergency room. The incision, which can be extended across the sternum with a clamshell incision, allows rapid release of cardiac tamponade, control of cardiovascular bleeding, internal cardiac massage, and descending thoracic aortic cross-clamping.¹⁰

A negative clinical test after primary investigation in PCI patients does not necessarily rule out heart injury. Extended focused assessment with sonography for trauma (EFAST) even after 24 hours can reveal damage that cannot be detected immediately, must be repeated. In this light, we examined the management of patients with penetrating lesions and detailed the algorithms we have used over the past six years incorporating both EFAST and SPW.² In our protocol, subxiphoid pericardial window (SPW) is reserved for a specific subgroup of patients with delayed presentation of traumatic pericardial effusion without hemodynamic instability and serves to eliminate the presence of cardiac damage in patients requiring laparotomy due to abdominal trauma. Our predominantly clinical approach takes into account injury sites, hemodynamic conditions, chest X-ray results, EFAST, arterial blood gases, rapid review, and requires immediate coordination between experienced emergency physicians and trauma team surgeons.⁶

Median sternotomy should be considered as an incision of choice in emergency cases for resuscitation purposes, where trauma penetrating into the heart box can result in damage to the heart or large vessels. In our case, the presence of a huge left pleural effusion prompted the

thoracic surgeon to choose the left anterior surgical approach, assuming that this may be the most important injury. This approach determined the optimal exposure of the left lung. However, when the pericardium was opened and the right ventricular injury was confirmed, cardiac exposure was much harder to achieve. In fact, a midline sternotomy would have involved a much simpler surgical procedure.⁷

In pulseless patients who show signs of life in the Emergency Department after penetrating a chest injury, some authors strongly recommend emergency room thoracotomy (EDT).⁹ The EDT recommendations are based on moderate-quality evidence for patients who are in cardiac arrest but have previously experienced cardiac activity or who have unresponsive hypotension (blood pressure under 70 mmHg) despite appropriate resuscitation. This procedure requires left anterolateral thoracotomy in the supine position in the emergency room. The incision, which can be extended through the sternum with a clamshell incision, allows rapid release of cardiac tamponade, control of cardiovascular bleeding, internal cardiac massage, and descending aortic cross tightening.⁸

CONCLUSION

Surgeon must be able to decide the technique of approach in the operating room considering the site of injury and the presence of involved organs. Thoracotomy patient can also receive median sternotomy if the cardiac injuries could not be repaired through thoracotomy. In addition, some patients with median sternotomy also received additional thoracotomy due to their pulmonary injuries.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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