Case report

Negative FAST and echocardiography in penetrating cardiac injuries decompressing to the chest and peritoneal cavities

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1. Introduction

Penetrating cardiac injuries are associated with high mortality rates with the majority of patients succumbing on scene despite aggressive resuscitation attempts. Moreover, even those who do survive the initial assault pose a difficult challenge to trauma surgeons, with a reported in-hospital mortality rates of 48–71% in major trauma centres.12 Most patients present with profound hypotension and require immediate surgical intervention, yet others may present to the emergency department without overt symptoms and signs of significant heart injury.10 Thus, the diagnosis of cardiac injury in the latter group of patients should be made promptly in order to avoid delay in treatment and preventable deaths.

The initial evaluation of a trauma patient sustaining penetrating chest trauma includes physical examination and chest radiography. The sensitivity and specificity of both examinations for diagnosing cardiac injury is relatively low.7,6,8 When cardiac injury is suspected, different tools may assist in diagnosing heart injury including, subxiphoid exploration (SXE), trans-thoracic echocardiography (TTE) and focused assessment with sonography for trauma (FAST). In recent years, FAST examination has become an integral part of the primary survey and was found to be highly valuable in the diagnosis of pericardial effusion (sensitivity, 92–100%; specificity, 99–100%), which is very commonly associated with penetrating cardiac injuries.11,12 Nevertheless, some authors have expressed their concern about the ability of ultrasound to rule out of haemopericardium and heart injuries, and hence lead to delayed diagnosis and treatment of significant heart injury.9

We present two cases of clinically significant penetrating cardiac injuries undiagnosed by both FAST examination and trans-thoracic echocardiography.

2. Case 1

A 30 year old man was stabbed in the chest by a knife and was transported immediately to the emergency department. On arrival, the patient was alert, with a heart rate of 120 beats/min, blood pressure of 90/50 mmHg, and respiratory rate of 20 breaths/min despite on-going fluid replacement. A stab wound was found on the anterior axillary line, approximately 2 cm lateral and 2 cm inferior to his left nipple. Diminished breath sounds were noted over the left hemithorax.

There was no neck veins dilatation. Normal heart sounds and no murmurs were noted.

Chest X-ray demonstrated left sided haemothorax. A chest tube was placed in the left hemithorax and 1000 ml of blood were evacuated. The patient’s electrocardiogram showed sinus rhythm. The patient’s initial haemoglobin was 11.5 mg/dl. Bedside FAST examination did not demonstrate pericardial effusion or free intraperitoneal fluid. Similarly, pericardial fluid was not detected by TTE. Following this initial survey treatment continued with crystalloid solution and two units of blood. His heart rate decreased to 104 beats/min but the systolic blood pressure remained 90 mmHg. One hour after the insertion of the chest tube the blood output amounted to 1500 ml. He was then taken immediately to the operating room for an exploratory left anterolateral thoracotomy. A significant amount of fresh blood with clots was evacuated and a one cm laceration at the apex of the left ventricle of the heart was found. The injury was remote from any coronary artery branches and was bleeding exclusively into the left hemithorax. The laceration was repaired primarily using horizontal mattress sutures. The postoperative course was uneventful and the patient was discharged from the hospital after 8 days.

3. Case 2

A 22 year-old man was stabbed in the chest by a knife and was transported immediately to the emergency department. On arrival, the patient was alert, with a heart rate of 110 beats/min, blood pressure of 110/70 mmHg, and respiratory rate of 18 breaths/min with oxygen saturation of 97% on room air. A single stab wound at the anterior chest was found, located just above the xiphoid process. Neck veins were not distended. Examination of his chest demonstrated clear bilateral breath sounds and no evidence of crepitus. Heart rate was regular, and no murmurs, heaves, or rubs were noted. His abdomen was not distended and without evidence of peritonitis.

A chest radiograph obtained in the trauma bay revealed no pneumo/haemothorax, or enlarged cardiac silhouette. The
patient’s electrocardiogram showed sinus rhythm. The patient’s initial haemoglobin was 13.5 mg/dl. Bedside FAST did not show signs of pericardial effusion in sub-xiphoid and left parasternal windows. Significant amount of intra-peritoneal free fluid in the abdomen and pelvis in all three views was found. Subsequent TTE was performed and no pericardial fluid was demonstrated. Approximately 20 min after arriving at the emergency department, the patient’s blood pressure dropped to 85/50 mm and the heart rate increased to 120 beats/min. The patient was urgently rushed to the operating room. A midline laparotomy from xiphoid to pubis was performed and 2000 ml of blood were evacuated immediately from the peritoneal cavity. A 3 cm laceration was found in the diaphragmatic surface of the liver with no signs of active bleeding. In addition a similarly sized laceration was found in the midline of the tendinous portion of the diaphragm with active pulsating bleeding. A left antero-lateral thoracotomy was immediately performed without evidence of blood in the left thorax and pericardium. The pericardium was opened and a two cm laceration actively bleeding to the abdomen was found at the left ventricle apex of the heart. The lacerations were repaired primarily using horizontal mattress sutures. The postoperative course was unremarkable and the patient was discharged from the hospital after 6 days.

4. Discussion

Penetrating cardiac injuries commonly result in rapid exsanguination or cardiac arrest secondary to cardiac tamponade, leading to an on-scene mortality rate of about 60%. For those who do survive the initial insult prompt diagnosis and treatment are critical factors in saving their lives. In many cases, physical examination is unreliable and pathognomonic signs such as pulsus paradoxus or Beck’s triad (venous pressure elevation, decline in arterial pressure, and muffled heart tones) presents in approximately 10% of patients. Surgical subxiphoid pericardial window is the most accurate means for detecting cardiac injury, yet it is an invasive time consuming procedure with considerable morbidity and may not be readily performed by inexperienced surgeons especially in unstable patients. Thus, ultrasound, which is noninvasive and can rapidly detect pericardial effusion have gained great popularity and have become the most commonly used tools for the diagnosis of heart injuries in penetrating chest trauma. Large scale studies have repeatedly shown extremely high accuracy rates for FAST examination for the diagnosis of clinically relevant penetrating heart injuries. For example, Rozycki et al. evaluated the role of surgeon-performed ultrasound in determining the need for early operative intervention in patients with possible penetrating cardiac wounds. In a 13-month period, 247 patients with penetrating chest trauma underwent FAST examination of the pericardial region. A 95.5% true-negative result was noted. There were no false-negative or false-positive results in this series. As such, a negative FAST examination is considered normal by many trauma health providers as safe and sound indication for ruling out penetrating heart injuries.

Nevertheless, despite the strong evidence supporting the important role of pericardial ultrasonography as a part of the FAST examination, several authors have highlighted the pitfalls of this examination in penetrating cardiac injuries. For example, the reported their results obtained from a series of 313 consecutive patients with penetrating precordial or transthoracic injuries. Two patients (0.6%) were found to have false-positive pericardial FAST examinations. Both patients had large left haemothoraces and blood in the mediastinum without associated heart injuries. The authors suggested that a massive haemothorax that surrounds the pericardium may result in a false-positive examination and therefore recommend repeating the examination after the evacuation of blood by tube thoracostomy. Moreover, massive haemothorax may also lead to false-negative results. In a cohort of 228 patients with penetrating wounds to the precordial area, false-negative FAST examinations were found in 5 patients (2.1%). All five patients also had concurrent left haemothoraces. The fact that a large haemothorax may obscure a small haemopericardium was also suggested in other studies. Meyer et al. evaluated 145 haemodynamically stable patients for occult cardiac injuries. All patients underwent TTE and SXE. The TTE missed four significant injuries. When comparing SXE with TTE in patients without haemothorax, however, the sensitivity (100% vs. 100%), specificity (89% vs. 91%), and accuracy (90% vs. 91%) rates were comparable between SXE and TTE, suggesting that that TTE is an acceptable diagnostic option for detecting cardiac injury, but may have significant limitations in identifying cardiac injuries in patients with haemothorax. Another potential pitfall is the dependency on operator performance. This performance may be limited by both operator experience and technical considerations.

Here, we report two cases of negative FAST and TTE examinations in patients with potentially lethal cardiac injuries. In the first case the patient sustained penetrating cardiac injury presenting as a large haemothorax. The possibility of a blood decompressing into the thoracic cavity resulting in negative FAST and TEE examinations was initially described by Rozycki et al. This scenario is uncommon, the “negative” result of FAST examination may lead the surgeon to rule out the presence of a significant cardiac injury. In our case, the patient underwent surgery urgently due to haemodynamic instability and rapid accumulation of blood in the chest which ultimately led to the relatively rapid diagnosis of a significant cardiac injury. In the second case, FAST identified a large accumulation of blood in the peritoneal cavity, but failed to identify clinically significant cardiac injury. As a result the patient was rushed to surgery for exploratory laparotomy. Thus, as a result of lack of initial diagnosis of cardiac injury the wrong cavity was explored first, which theoretically could have had significant impact on the patient’s outcome.

These cases demonstrate the unique challenges presenting before the trauma surgeon in the initial evaluation and treatment of patients with penetrating trauma to the anterior chest wall. Penetrating trauma to the anterior chest may violate the mediastinal, thoracic, and peritoneal cavities. Here we show that the presence of a concurrent laceration in the pericardial sac may allow blood to stream from the cardiac wound into the adjacent thoracic or abdominal cavity. In such cases, FAST and transthoracic echocardiography may fail to detect injury because fluid does not accumulate in the pericardium, leading to “negative” pericardial FAST examinations.

Thus, the reported cases here illustrate a particular potential pitfall of FAST examination in ruling out cardiac injuries in unstable patients with penetrating chest trauma. Although the scenario of blood decompressing into the thorax has been previously described, to the best of our knowledge this is the first report demonstrating the dissipation of blood through a diaphragmatic laceration leading to significant haemothorax without concomitant pericardial effusion or haemothorax.

In summary, FAST is a rapid and accurate diagnostic modality for the detection of haemopericardium in patients with penetrating thoracic trauma. Although the absence of pericardial fluid rules out tamponade, it may miss significant cardiac injuries that
decompress to adjacent cavities. Thus, high index of suspicion for cardiac injuries should be raised in patients with pericardial stab wounds with haemothoraces or blood in the peritoneal cavity.

References