
EMERGENCY THORACOTOMY FOR CARDIAC OR GREAT VESSEL INJURIES : A REPT OF 5 CASES.**Abdulsalam Y Al Museilih**

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Introduction

The different modes of injury to the heart extend from motor vehicle accidents to penetrating injury by a pencil tip¹. The incidence of penetrating cardiac injuries appears to be rising, presumably because of an increase in civilian violence².

Penetrating cardiac injuries are still a challenge for surgeons because of their difficulty as to the diagnosis, bad prognosis and the necessity of acute operation³.

In 1885, Billorth stated that the surgeon who should attempt to suture a wound of the heart would loose the respect of his colleagues. Pages reiterated this in 1896. According to him: no new method can overcome the natural difficulties that attend a wound of the heart. Paradoxically, the first reported successful repair of cardiac injury was performed in the same year 1896, when Rehn of Munich was forced to place three silk sutures to a 1.5 cm right ventricular stab wound of a discharged soldier. The first reported repair of a cardiac wound in the United States was performed by brothers L.L. Hill and R.S. Hill in 1902, when they operated on a kitchen table in Alabama. The attitude of observation was changed to active operative intervention after the turning of the 19th century³.

Penetrating trauma to the thoracic vessels was not extensively reported until the 20th century because of the absence of survivors. In 1934, Alfred Blalock was the first American surgeon to successfully repair an aortic injury⁴.

Over one year period (January 2004 to February 2005), five patients (4 males and one female) with cardiac or great vessel injuries were admitted and managed successfully in Sulaimania Teaching Hospital, Iraqi Kurdistan Region. All of them had emergency operations (four left thoracotomy and one median sternotomy) with good outcome. The cases are presented with literature review.

Case-1: Hariem Kareem (Left main pulmonary artery tear)

It was the midnight of 18th January 2004 when I was phoned to see a young chap with life-threatening bleeding from left-sided chest tube after being shouted with a bullet. The entrance was over the manubrium sterni while the exit was from left back near left scapula. The patient was extremely pale and shocked. More than 3 liters of blood were drained via the chest tube; still the bleeding was brisk once the clamp on the tube was removed. Clinically and radiologically, there was massive haemothorax with great mediastinal shift. Emergency thoracotomy was done in minutes. Using the available surgical instruments, we could find a big laceration in left main pulmonary artery beside laceration of

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LUL. The lacerated LMPA was repaired by 3-0 silk suture. The patient had an uneventful recovery. The postoperative chest radiograph is shown in Fig 1.

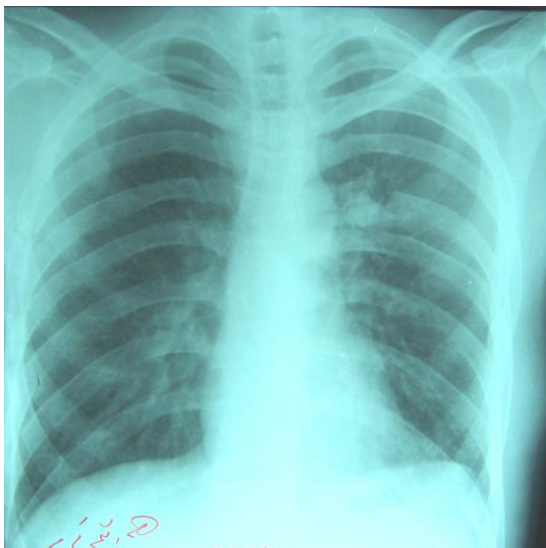


Fig.1

Case-2: Salam (Left subclavian artery injury)

A 30 years old man admitted to the hospital in February 2005 with blunt chest trauma due to road traffic accident. He was diagnosed as a case of fracture left first rib and was managed conservatively by a general surgeon. Four days later, the patient was discovered to have deterioration in his general condition. He had severe dyspnea and pallor. Left sided haemothorax was detected and a chest tube was placed. The initial drainage was significant (around 1400 cc) and over few hours, it reached 2000 cc. The patient had received adequate blood transfusion, however, his shock state persisted and chest tube drainage continued. I was called to see him 5 days after the trauma. He was in extreme shortness of breath and pallor. His pulse rate exceeded 120 bpm and Bp equaled 70/ 40 mm Hg. The left side of the chest was dull to percussion and breath sounds were absent. The patient was shouting for air. He was taken urgently to the

theatre. Meanwhile, his chest radiographs were quickly reviewed. The first CXR obtained on admission (Fig 2) revealed fracture left first rib and



Fig.2

surgical emphysema but no evidence of haemothorax. CXRs obtained later (Fig 3), revealed massive left-sided haemothorax and mediastinal shift to the opposite side.

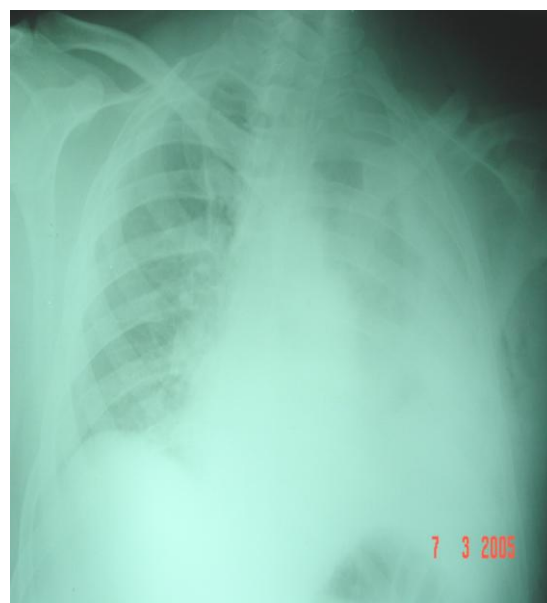


Fig.3

Urgent left postero-lateral thoracotomy was performed in minutes. The chest was full with blood clots as well as active bleeding. The blood was evacuated using suction machines as well as hands. The bleeder was an injured left subclavian artery at the extreme apex of the chest (a lateral tear caused by the fractured first rib which could be felt near the torn vessel). The arterial injury was repaired. Haemostasis was secured. No other injury was found. Two chest tubes were placed. The chest was then closed in layers. Postoperative course was uneventful. The left lung had full expansion as shown by chest radiograph (Fig 4). The left hand was viable. The patient had gone home 10 days after surgery in a perfect health.

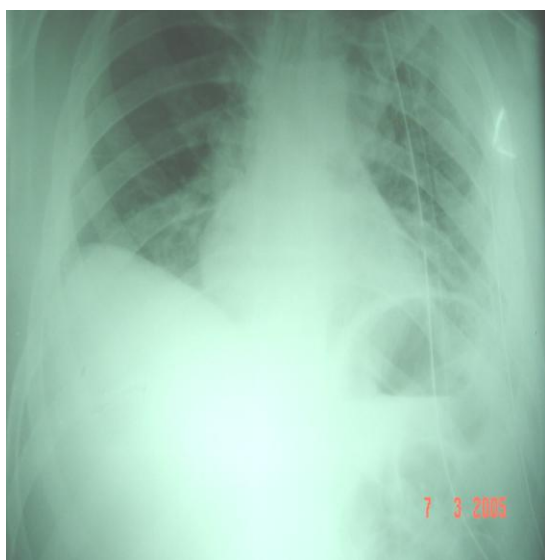


Fig.4

Case-3: Rahmatulla Baqi (R. ventricular injury, LIMA and L. brachial artery transection)

Rahmatulla Baqi, a 35 year old man brought to the Emergency Department on 25th of September 2004, 3 hours after being stabbed. There were 2 stab wounds. The first one was in the left 4th intercostal space just to the left of sternum. The second wound was in the lateral aspect of left upper arm. He was conscious but extremely pale and shocked. Profuse bleeding occurred from

the chest wound on leaning forward. PR was rapid and feeble. Bp=80/60 mmHg. Heart sounds were inaudible. Chest auscultation revealed good air entry bilaterally. The neck was swollen and its veins distended. The chest radiograph (Fig 5) showed a normal-sized heart with no evidence of haemo- or pneumothorax. The features were highly suggestive of cardiac injury and tamponade. Regarding the upper arm injury; the bleeding was controlled by a tight dressing. The limb was swollen, tense and cold. Peripheral pulses were absent. Thus brachial artery injury was highly suspected. The patient was taken urgently to the theatre. Median sternotomy was performed. Extra pericardial fat was haematized. Once the pericardium was incised, clots were evacuated. Profuse bleeding occurred. A big wound is felt in right ventricle; sealed temporarily by finger. A vascular clamp is applied to the site of injury. Blood and IV fluid were rapidly given. The wound is sutured by interrupted 2-0 silk sutures buttressed by pieces of Dacron patch. The clamp is then released. Bleeding from ventricular wound has completely ceased. Lacerated LIMA was also bleeding profusely. To get a control of it, the left pleural space was entered. The LIMA pedicle was ligated. A tube drain is left in pericardial sac. The pericardial edges were approximated by interrupted 2-0 silk sutures. A tube drain was also placed in left pleural space. The wound was then closed in the routine way.

The left upper arm wound was then explored. Fasciotomy of forearm was performed immediately. The tissues were still viable. The brachial artery was found completely transected. While the nerves were partially injured. The artery was repaired by end to end anastomosis. The wound was partially closed.

The postoperative course was uneventful. The drains were removed in 48 hours. Postoperative haemodynamic

state, CXR and ECG were normal. The left upper limb is viable. Fasciotomy wound was closed on 7th postoperative day. Echocardiography on 10th postoperative day was normal.

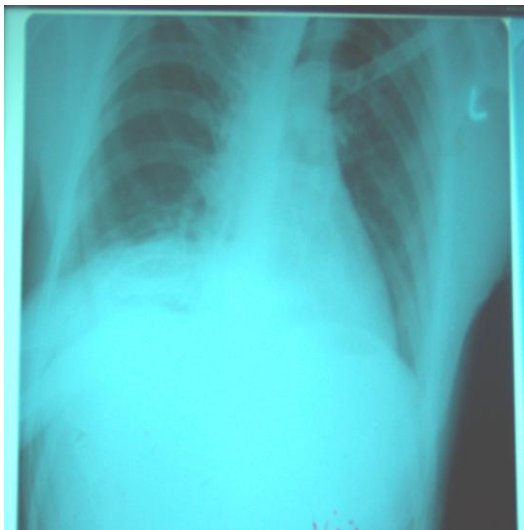


Fig.5

Case-4: Zain Addeen (Pulmonary trunk tear, LIMA transection and traumatic VSD); An 18 year old chap arrived to our hospital at 29th October 2004 with a stab wound to his anterior chest. The wound was in left 2nd inter-costal space between the edge of sternum and mid-clavicular line about one inch in length. He was pale, dyspnoic and shocked. Left-sided chest tube drained about 1800 ml of blood with continuous loss. Heart sounds were faint. Neck veins were not distended. CXR revealed left-sided radio-opaque hemithorax. The patient was resuscitated by transfusion of 5 units of blood but shock persisted. LIMA and/or intercostal artery were suspected to be injured beside possible cardiac injury. Urgent left thoracotomy was performed. The thoracic cavity was full with arterial blood and clots. Rapid evacuation of blood and clots was done. Arterial bleeding was observed from LIMA transection besides profuse venous bleeding from a hole in the pericardium. The pericardium was incised obliquely anterior to the left phrenic nerve. Pericardial stay sutures were placed. A

tear about 2 cms is seen at origin of pulmonary trunk with no bleeding; probably due to hypotension. The tear is sutured by continuous 2-0 silk. The lacerated LIMA was ligated by silk. Haemostasis was secured. The edges of pericardium were approximated by interrupted 2-0 silk sutures. Two chest tubes were placed. The chest was closed in layers. The patient recovered from anaesthesia slowly. He was given adequate intravenous fluid and 200 cc of 20% manitol until good urine output was obtained. The chest tubes drained nothing for few hours post-operatively. Next day: the patient was conscious but pale. The basal chest tube drained 1800 cc blood! A decision was made to re-explore him urgently. When explored; the chest was full with liquid blood without clots. The site of pulmonary trunk and LIMA repair were inspected. No surgical bleeder was found but continuous capillary ooze. Bleeding diathesis due to massive transfusion was suspected. Thus the patient was transfused with fresh blood and given vit-K and cyclocaprone injections. After tedious haemostasis, the chest was closed in layers.

Next day: The drainage decreased to 700 cc of diluted red blood. CXR showed full expansion of both lungs (Fig 6).

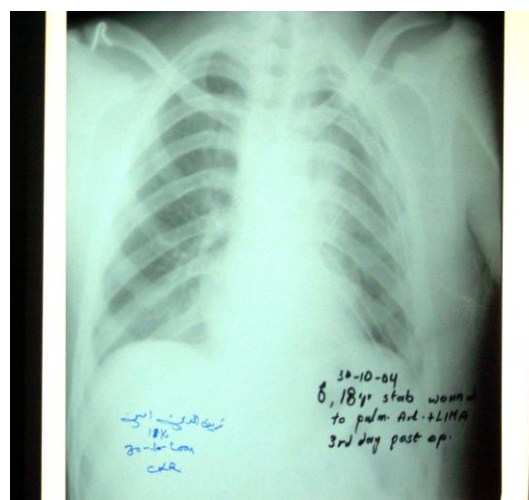


Fig.6

Later on, he was discovered to have a systolic murmur all over the precordium.

Echocardiography revealed a small post-traumatic ventricular septal defect. The patient was discharged home on 10th postoperative day in a good health. Follow up was advised.

Case-5: Kaniao Othman (Right ventricular wound)

A 16 year old girl had been brought to the hospital on the 7th of January 2005 with a stab wound to her left anterior chest. She has arrived to the hospital 1 hour after the injury. She was extremely pale and dyspnoic. Air entry was absent on left side. Chest radiograph (Fig 7) revealed totally radio-opaque left hemithorax with shift of mediastinum to right side.



Fig.7

Chest tube was placed and drained 1200 cc of blood immediately. Drainage continued and reached 2500 cc within 2 hours. She was brought to the operation theatre urgently (almost one hour after hospitalization). She was in a gasping state. Left postero-lateral thoracotomy was performed in minutes. The chest was full with clots and blood. The pericardium was distended with blood. There was a wound in anterior chest wall and pericardium with active bleeding through the pericardial wound. The clots were evacuated quickly. The pericardial wound was extended parallel to the phrenic nerve. Clots were removed from inside the pericardium. A wound was found in right ventricle near the

atrioventricular junction with profuse bleeding. The bleeding was temporarily sealed by a digit. A vascular clamp was applied. The tear was sutured by interrupted 1-silk sutures. Haemostasis was secured. Two chest tubes were placed. The chest was closed in layers. The patient had recovered from anaesthesia smoothly. Postoperative course was smooth. Fig 8 shows her postoperative chest film.

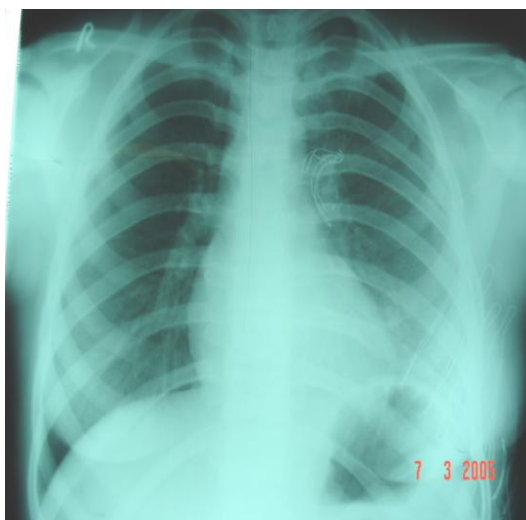


Fig.8

The ECG showed an ST elevation followed by Q wave and T inversion in V2- V6, lead 3 and aVF (features of acute infero-lateral myocardial infarction). She was discharged well on 10th postoperative day. Echo showed apical hypokinesia. Apart from ECG and echo findings, the patient is doing well now as seen on regular follow-up visits.

Case	Type of Trauma	Findings at exploration
1	Bullet injury	Laceration of left main pulmonary artery LUL laceration Fracture ribs
2	RTA- Blunt trauma	Laceration of left subclavian artery Fracture first rib
3	Stab wounds	Right ventricular wound Lacerated LIMA Transaction of left brachial artery
4	Stab wound	Pulmonary trunk tear LIMA transaction Post-traumatic VSD
5	Stab wound	Right ventricular wound

Discussion

Apart from case 2, all patients in this article had sustained penetrating injuries to anterior chest. Bullet injury in case 1 and stab wounds in cases 3, 4 and 5. The wounds were located centrally. Anteriorly, injuries to the heart should be presumed to have occurred if entry points are present anywhere between the 2 midclavicular lines. On occasion, significant injury to the heart has occurred from entry points lateral to these margins, as in gunshot or missile injuries. Exceptionally long penetrating instruments and weapons (eg, arrows, swords, and lances) can also directly penetrate the heart from a distant entry point⁴.

All patients in this article except case 3 had massive haemothorax as revealed by tube thoracostomy. Moreover, case 4 had features of tamponade as well. In case 3, there was no evidence of haemothorax but features of tamponade and external bleeding from the stab wound on leaning forwards. Thus, thoracotomy was performed urgently in case 1, 4 and 5 for continuing bleeding (defined as immediate chest tube drainage of 1500 ml or more of blood, or loss of blood more than 200 ml/ hr for the next 4 hrs after chest tube placement). In case 2, left subclavian artery injury was unfortunately missed. It was discovered on the 4th day. Fracture ribs can cause a haemothorax which develops insidiously. Careful follow up was necessary for early diagnosis. Moreover, this chap should have a chest tube placement on the day of admission as surgical emphysema was present and it indicates a parenchymal lung injury and possibly an underlying pneumothorax. Left thoracotomy was chosen as that was the side of the thoracic wound and the developing haemothorax. Median sternotomy was chosen in case 3; as this is the approach of choice to get access to all cardiac chambers^{4,5}.

All cases had initial resuscitation followed by urgent thoracotomy as there was no response to resuscitation. Thoracotomy was done soon after arrival to hospital and it was done in minutes. The patient with penetrating cardiac injury should be taken to the operation room as quickly as possible. As stated by Kirklin and Barrat Boyes, no more than 5 minutes need elapse between admission and the patients transfer to the operating table⁵. The bleeding was controlled quickly intra-operatively after evacuation of blood from the thoracic cavity. Digital occlusion of cardiac and great vessel wounds was achieved followed by repair. A vascular clamp was applied to LMPA tear in case 1; then repair was accomplished. No cardiac arrest occurred and no arrhythmias.

Associated injuries were encountered in the presented cases. LIMA transaction was seen in cases 3 and 4. This is a common association with penetrating cardiac wounds⁶. It was treated by ligation in both cases. Brachial artery transaction in case 3; this was repaired after repair of cardiac wound in the standard method with good outcome. Pulmonary parenchymal laceration was found in case 1; repaired without sequelae. Rib fracture in case 1 and 2. Post-traumatic VSD was discovered in case 4.

According to literature, VSDs associated with cardiac trauma, either penetrating or blunt, are uncommon but not rare. Review of the literature of penetrating cardiac trauma reports the incidence of ventricular septal defect (VSD) to be 4.5%. Most of patients are usually operated on because of heart failure and/or significant left-to-right shunt.

More recently, some have reported transcatheter closure for perimembranous or muscular VSD using a new device, the Amplatzer VSD occluder. In such cases, the VSD must

not be too close to the aortic and atrioventricular valves to allow a safe procedure and no valvular device protrusion⁷.

Case 4 was re-explored within 24 hours because of bleeding. This was a complication of massive transfusion and not a surgical bleeding. None of the patients developed wound infection. All left the hospital 10 days postoperatively in good health.

The only significant morbidity was acute myocardial infarction in case 5. This is most likely due to coronary artery injury by the stab. Fortunately, the patient did not develop any haemodynamic instability or arrhythmia following surgery. There was no ischaemic chest pain. The diagnosis was based on ECG changes. A cardiologist opinion was obtained and according to his advice, she has received a B-blocker therapy (Propranolol 40mg b.d.). The patient is regularly seen at follow up. Coronary angiography is advised in the future. The consequences of penetrating trauma to the heart naturally depend on the structures involved: damage to the chamber of the heart or coronary vessels will result in a spectrum in which the extremes are tamponade or haemorrhage. The most common sites of cardiac penetration, in order of prevalence are right ventricle, left ventricle and right atrium².

The two life-threatening problems after penetrating cardiac trauma are tamponade and haemorrhage. Tamponade develops rapidly as the normal pericardium can accommodate only 100 to 250 ml of blood. Small wounds, such as those from an ice pick or a knife, often produce tamponade because the laceration in the pericardium is small. Larger wounds, produced by bullets or large knives, threaten immediate death from exsanguinations as blood can be expelled

through the pericardial laceration into the pleural cavity. Generally speaking, tamponade carries a better prognosis than frank haemorrhage^{2, 8}.

Traumatic cardiac penetration is highly lethal, with case fatality rates of 70-80%. The degree of anatomic injury and occurrence of cardiac standstill, both related to the mechanism of injury, determine survival probability. Patients who reach the hospital before cardiac arrest occurs usually survive^{3, 4}.

In one population-based study overall survival after penetrating cardiac injury was 19%, and survival of those who reached the hospital was 43%.

Predictors of survival as reported from high-volume cardiac trauma units included presence of vital signs on hospital arrival, early surgical exploration in the operating theatre, absence of associated aortic injury, and absence of other associated lethal injuries^{4, 9}.

The great vessels of the chest include the aorta, its major branches at the arch (e.g., innominate, carotid, subclavian), and the major pulmonary arteries. Damage to vascular structures depends on the specific location and degree of vessel disruption; arterial injuries are more rapidly fatal. The prevalence of great vessel injuries ranges from 0.3-10%.

More than 90% of thoracic great vessel injuries are caused by penetrating trauma (i.e., gunshot, shrapnel, stab wounds, therapeutic misadventures). Historically, thoracic injuries are associated with a high morbidity rate; however, Pate and coworkers reported a 71% survival rate in patients who reach the hospital alive after penetrating chest injuries. The trauma surgeon must resuscitate, diagnose, and treat the patient within minutes following admission to the trauma emergency unit⁴.

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