Penetrating thoracic trauma

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Abstract

A penetrating injury to the chest may be one of the more feared crises to face the surgical trainee. The patients are usually unstable, often uncooperative, and the solution is usually expedient surgery and one cannot procrastinate by requesting a CT scan. Rarely can the situation wait till a cardiothoracic surgeon arrives. In a major trauma centre, where the call from ambulance control will have drawn an experienced team to the resuscitation area, a well-rehearsed operative resuscitation will ensue, performed by surgeons whose main field of expertise may be emergency medicine, general surgery or even orthopaedic surgery. Due to the urgency of such cases, they may also present to any hospital with an A & E department, mandating that all doctors working in emergency care have a knowledge of penetrating injuries and the emergency surgery required to control their consequences. This article aims to help the surgical and emergency medicine trainee provide either definitive care or stabilization of the patient until specialist help arrives.

Keywords Penetrating injury; thoracic; trauma

Introduction

The 2010 Review of Major Trauma Care in England concluded that while there were significant variations in the standard of care for major trauma patients, 60% of patients received levels of care that were 'less than good practice'.[1] This has resulted in a nationwide reorganization of trauma services by developing individual Trauma Networks, each focused around a Major Trauma Centre (MTC). As yet the impact of these changes has not been fully assessed, but the 140 cases of penetrating thoracic trauma reported by one MTC in south London in the first year after centralization justifies the presence of a consultant-led trauma team, onsite 24 hours a day, 7 days a week.[2]

Which patients should have a thoracotomy in A & E?

Surgical management of penetrating thoracic trauma may be commenced by the Helicopter Emergency Medicine Service (HEMS) before the patient even reaches hospital. The London Air Ambulance Service performs an average of two resuscitative thoracotomies per month, achieving a survival rate of 18%.[3]

Emergency room thoracotomy (ERT) should be considered for known or potential cardiac injuries when the victim is lifeless but where there have been signs of life in transit, or in a critically unstable patient when cardiac arrest appears imminent. The 'cardiac diamond' is bounded by the sternal notch superiorly, the nipples laterally and the umbilicus inferiorly (Figure 1). An assailant's knife can reach the heart or great vessels from anywhere within this diamond and hence any penetrating injury within this area must be assumed to have injured the heart until proved otherwise. The cardiac diamond must also be projected onto the back, particularly the left side where the descending thoracic aorta can be injured.

If the haemodynamics are stabilized with fluid resuscitation but there is a clinical suspicion of tamponade – the patient is agitated, unwilling to lie flat with raised jugular venous pressure and muffled heart sounds – it may be more appropriate to transfer the patient immediately to an operating room for further assessment and possibly median sternotomy.

The overall outcomes associated with ERT are poor, but it is appropriate in certain circumstances. Where there has been no cardiac output on arrival of the ambulance crew at the scene or cardiopulmonary resuscitation for longer than 15 minutes, survival rate is dire and associated with profound neurological sequelae. In these instances ERT is often futile. Conversely, those patients with single stab wounds or minimal delay between cardiac arrest and ERT have survival rates up to 24%.[4]

The emergency room thoracotomy

The ambulance service should place a stand-by call to A & E for all penetrating trauma. The Resuscitation Room should immediately be prepared for an ERT, the anaesthetic team made available along with O negative blood, rapid infusion pumps and

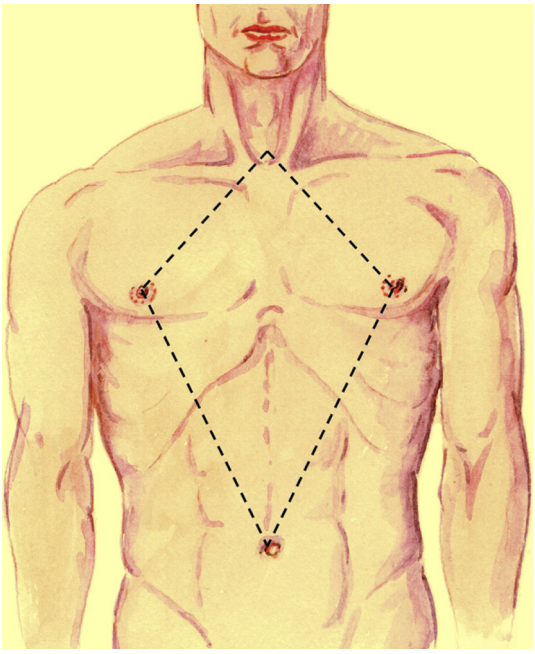

Figure 1 The 'cardiac diamond'.

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the thoracotomy set (see Table 1). An emergency slot in theatre should be cleared for use if the patient is stable enough for transfer.

A cardiac-trained surgeon may prefer the exposure through a median sternotomy, but locating and operating the saw in an unfamiliar environment with limited time available may be difficult. The incision of choice for an ERT is a left fourth intercostal space anterolateral thoracotomy (curving just beneath the nipple in a slim male, Figure 2) because a scalpel is all that is required. Regardless of the location of the entry wound, start with a left-sided incision to reach the pericardium. This can be mirrored on the right side, with heavy scissors used to cross the sternum, to create a clamshell thoracotomy for full mediastinal exposure. Alternatively, the left-sided incision can be extended to the abdomen for subdiaphragmatic injuries. The two most common mistakes are to make it too low or too small. The aortic arch is at the level of the sternomanubrial junction (second intercostal space) and the xiphisternum is well below the base of the heart. If too low, a second intercostal incision may be made or it can be converted to a median sternotomy.

Tissue bleeding is not an issue as this is being performed in patients with a low or absent cardiac output, so do not worry about the internal mammary arteries. Cut straight down to the pleura; once breached, the lung can be pushed clear with your hand while you open the remaining pleura. To obtain access to the heart use either a rib spreader if available or a gloved assistant to pull the ribs open.

Relieving tamponade

Cardiac tamponade is more common than exsanguination, so the priority is to get the pericardium open. Identify the phrenic nerve, grasp the pericardium between two artery forceps anterior to the phrenic nerve, tent it up and incise between the clamps. The removal of blood and blood clot from the pericardial space often results in a rapid return of the cardiac output and bleeding from the wound may now become evident. If the patient has presented in asystole and no tamponade is present, further resuscitative efforts may be futile.

Internal cardiac massage

If internal cardiac massage is needed, slide one hand into the opened pericardium behind the heart and compress it anteriorly against the back of the sternum. There is no point massaging an empty heart that continues to bleed profusely. At this point an assistant can be performing internal cardiac massage while you complete the clamshell incision. If venous access is limiting fluid resuscitation, a large cannula can be inserted directly into the right atrium.

Suturing the heart

Most stab or missile injuries to the heart can be controlled simply by placing a finger (preferably your assistant's finger) on the hole. The situation is now stabilized, which allows the anaesthetist to catch up with fluids and allows you to catch your breath. At this stage you may wait for cardiothoracic or senior help to arrive or close the defect yourself. A cardiac surgeon would use a Prolene suture buttressed with Teflon, but you can cut pericardial pledgets instead. Suturing is performed as a horizontal mattress stitch under your assistant's finger and tied neither so tight nor so shallow that it cuts through the myocardium.

When do you need a cardiac surgeon?

Larger coronary arteries can be avoided by placing the suture lateral and deep to the vessel. Small distal coronary vessels may be ligated. More complex injuries involving multiple chambers, large coronary arteries, valvular or septal lesions will need the input from a cardiac surgeon. Despite this, intracardiac valvular and septal injuries are rarely life-threatening in the acute setting and any period of cardiopulmonary bypass for trauma must be considered carefully due to the need for systemic heparinization. These are often repaired at a later stage following appropriate investigation with angiography and echocardiography. Sometimes haemodynamic instability may respond to a period of cardiopulmonary bypass support and one may have to be prepared to leave the chest open for a period of time. By the time the heart needs this level of support, cerebral and other organ damage may be irreversible.

Thoracic interventions in uncontrollable abdominal bleeding

In circumstances where there is large volume ongoing blood loss from the lower torso, the descending thoracic aorta can be clamped through an emergency thoracotomy until control in the abdomen is achieved. This should be kept to a minimum period as it can be associated with paralysis from spinal cord ischaemia.

Stabilization, focused investigation and planned thoracotomy in the more stable patient

More commonly the patient will not have arrested and will be more stable. This will allow full ATLS assessment, stabilization with intravenous fluids and chest drains and imaging with computer tomography (CT), ultrasound or echocardiogram.

The diagnostic chest drain

In combat zones, military medics are taught to insert bilateral chest drains in all thoracic trauma to achieve maximal benefit and stabilization in the field before any chest X-ray is taken. ATLS also emphasizes the diagnostic benefit of drain insertion prior to chest X-rays or CT scan. Needle decompression of a tension pneumothorax may be enough to change an emergency into a stable situation, but should be followed by formal chest drains. In most circumstances well placed chest drains, one anteroapical for air and one posterobasal for blood, are usually all that is required to allow the lung to re-expand. A fully expanded lung will tamponade most bleeding from the lung or chest wall, but the combination of a major air leak and residual clotted haemothorax may prevent satisfactory re-expansion.

Imaging or exploration

In the past, surgical exploration has been the rule rather than the exception for penetrating chest injuries. Modern imaging technologies are fast and accurate and may allow safer alternative strategies. Proficiency in Focus assessment using sonography in trauma (FAST) scanning is now part of the curriculum for every emergency medicine trainee. FAST scanning allows rapid assessment of the pericardial sac for tamponade, both costophrenic angles for haemothoraces, and the peritoneal and pelvic cavities for free fluid; while extended FAST (EFAST) also