Original Article

Emergency Thoracotomy for Blunt Thoracic Trauma

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Objectives: The indications for emergency thoracotomy are controversial for blunt trauma. The best results were seen in those patients who were stable enough to undergo thoracotomy in the operating theatre and survived the operation.

Methods: The hospital records of 29 patients who underwent emergency thoracotomy for blunt thoracic trauma were reviewed.

Results: Of 964 patients with thoracic trauma, 745 (77.3%) sustained blunt injury and 29 of these patients (3.9%) required emergency thoracotomy. Six patients underwent emergency department thoracotomy for blunt cardiac trauma and only one of them survived (16.7%). Of the 23 patients who had emergency thoracotomy at the operating theatre, 2 died in the early postoperative period due to pulmonary embolism (8.7%) and 21 of them survived (91.3%).

Conclusion: The results of emergency department thoracotomy in our series were extremely poor compared with the results of other reports, mainly due to rapid deterioration of hemodynamic condition caused by severe cardiac injury. The outcome from emergency thoracotomy in the operating theatre was encouraging, due particularly to the patients' status being stable enough to be transferred to a fully equipped operating theatre. We emphasize the importance of emergency medicine education programmes on rapid diagnosis of traumatic injuries with early intervention, and adequate hemodynamic and respiratory support.(Ann Thorac Cardiovasc Surg 2002; 8: 78–82)

Key words: emergency thoracotomy, blunt thoracic trauma

Introduction

In spite of the increasing rapidity of transport and improvements in the prehospital management of trauma victims, traumatic injuries still constitute one of the leading causes of death in all age groups and is the leading cause of death among children, adolescents and young adults.[1)] Penetrating and blunt thoracic injuries account for 25-50% of all traumatic injuries.[2)] The treatment of these injuries according to their etiologies is quite different. There is a major difference in the mechanism of injury, pathophysiology and treatment of penetrating and blunt thoracic injuries. A majority of these injuries can be managed nonoperatively with tube thoracotomy and general supportive treatment. A small subgroup of chest trauma victims, however, requires emergency thoracotomy.[3–5)] Emergency thoracotomy has become an established procedure in the management of life threatening chest injuries.[6–9)] However, the indications for emergency thoracotomy are controversial especially for blunt trauma.[10,11)]

We have reviewed 29 patients presenting with blunt chest trauma to the Accident and Emergency Department and have discussed the factors affecting the outcome.

Patients and Methods

From January 1999 to December 2000, 4,885 trauma victims were triaged to our Accident and Emergency Department (A&E) and 964 (19.7%) patients of whom 745 (77.3%) sustained blunt chest trauma were seen by thoracic and cardiovascular surgeons. One hundred fifty-three (15.9%) of these patients sustained severe chest trauma

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Table 1. Survival of patients by indications for emergency thoracotomy

	Survivors	Deaths
Patients with severe cardiac injury (n=6)		
Myocardial laceration and pericardial tamponade	1	4
Coronary artery damage and pericardial tamponade	–	1
Patients with severe thoracoabdominal injuries (n=23)		
Intraabdominal injuries with pulmonary injuries	2	1
Severe flail chest, sternal fracture, tension pneumothorax	1	1
Severe hemorrhage and air leak after tube thoracostomy	18	–

with 40 (4.1%) requiring emergency thoracotomy. There were 29 patients with blunt injury (mean age 32 years, 26 men and 3 women) and 11 patients with penetrating trauma. Twenty-nine blunt thoracic trauma patients were reviewed in this study (Table 1). Medical records of patients were reviewed for prehospital status, Glasgow Coma Scale (GCS), systolic blood pressure, respiratory rate, associated injuries, indications for emergency thoracotomy, perioperative blood and blood products replacement, intensive care unit (ICU) days, length of hospitalization, and complications.

Data analysis was performed using Microsoft Excel 2000.

Results

All patients sustained major thoracic trauma with associated extrathoracic injuries (Table 2). Motor vehicle accidents (MVAs) were the leading cause of thoracic injuries in our series (26/29, 89.7%). The other causes were free falls in 2 patients (6.9%) and direct impact in 1 patient (3.4%). Prehospital data were available for 25 (86.2%) of these patients. Endotracheal intubation was performed at the scene or in transit on 15 (52%) patients. Twenty-five victims were breathing on arrival at hospital and had an initial Glasgow Coma Scale of 12.8±1.2 (mean 13, min. 10, max. 15), systolic blood pressure greater than 50 mmHg and respiratory rate 25-35/min. Four patients who were in cardiopulmonary arrest or in agonal status and 2 patients with sudden hemodynamic deterioration in the emergency center, underwent emergency department thoracotomy (EDT). All other patients had an unstable hemodynamic and respiratory status, so a chest X-ray was not able to have been done to confirm a clinically suspected pneumothorax or hemothorax.

The relief of pericardial tamponade, cardiomyorraphy and large pulmonary paranchymal repair were performed on six patients during EDT. Four of them died intraoperatively due to severe hemodynamic failure, one was admitted to ICU postoperatively, but died in the early postoperative period because of an acute myocardial infarction, one patient survived to discharge (16.7%).

Table 2. Associated extrathoracic injuries

Type of injury	Number
Long-bone fractures	16
Closed head injury	14
Pelvic fracture	6
Cervical, thoracolomber spinal fracture	4
Diaphragmatic rupture	3
Liver laceration	2
Splenic rupture	2

Twenty-three victims went to the operating theatre after stabilization of vital signs at the A&E department in an average time of 35 min from admission (range 25-40 min). Three of them underwent laparotomy initially for severe blunt abdominal injury. In two victims, hemoperitoneum containing 2 L of blood due to laceration of the left lobe of the liver and spleen, mesenteric hemorrhage and diaphragmatic rupture was found; one had diaphragmatic and pericardial hernia which was originally not detected by ultrasound or paracentesis. Thoracotomy was performed for hemothorax and mild cardiac tamponade, which was diagnosed intraoperatively. Two victims were operated on for severe respiratory failure due to bilateral flail chest, sternal fracture and tension pneumothorax caused by a large pulmonary paranchymal laceration. These victims died in the early postoperative period due to pulmonary embolism caused by bilateral pelvis and long bones fractures. The remaining eighteen victims underwent thoracotomy due to severe hemorrhage and continued air leak after tube thoracostomy. At the operation, large pulmonary paranchymal laceration, diaphragmatic rupture or intercostal and internal mammary arterial injuries were detected. Twenty-one patients survived to discharge.

Table 3. Complications

	Survivors	Deaths
	(n=22)	(n=7)
Pneumonia/atelectasis	4	0
Wound infection	2	0
Deep vein thrombosis	2	0
Acute myocardial infarction	0	1
Pulmonary embolism	0	2

Of 15 patients in whom endotracheal intubation was performed at the scene or in transit, only 1 died in the perioperative period (6.7%). Six of the non-intubated patients expired intraoperatively or in the early postoperative period (6/14, 42.8%).

In relatively stable patients we prefer an anterolateral thoracotomy, because it provides a good exposure for the diaphragma, lung and hilum and it can also be extended with a laparotomy if needed. In four patients, we performed an anterior thoracotomy in a supine position. Primary pulmonary paranchymal repair was performed in the majority of the patients. Only two patients underwent lung resection (left lower lobectomy, 1; left superior lobe atypical segmentectomy, 1). Primary repair of the diaphragm was performed in two of three patients with diaphragmatic rupture and Gore-Tex® Dual Mesh™ (W.L. Gore & Associates, Inc., U.S.A.) was used in one.

Postoperative complications were seen in 11 patients and they were managed with adequate medical treatment in 8 of them (Table 3). Two patients who were operated in the operating room, expired in the early postoperative period (2/23, 8.7%). Mean hospital length of stay (ICU and ward) was 23 days. Blood product replacement averaged 12 units of whole blood, 5 units of packed red blood cells, 7 units of platelets and 6 units of fresh frozen plasma per patient.

Discussion

Thoracic injuries can be divided into a group of life-threatening problems that may require immediate treatment. The diagnosis in penetrating injury is rarely a problem, but blunt thoracic injuries are often not readily apparent, and may not appear at their worst until 48 to 72 hours after they occur.[12] Various pathophysiologic mechanisms may lead to problems in patients with blunt chest injuries and can lead to early death if not promptly recognized and treated. It is interesting to note that approximately 85% of patients with chest injuries that require operative intervention can be treated with tube thoracostomy, observation and pain control. Only 10 to 15% of patients with thoracic injury require formal thoracotomy.[3] The primary objectives of such emergency thoracotomy are to: 1) release pericardial tamponade; 2) control intrathoracic vascular or cardiac bleeding; 3) control massive air embolism or bronchopleural fistulae; 4) permit open cardiac massage; and 5) allow for temporary occlusion of the descending thoracic aorta in order to redistribute limited blood flow to the myocardium and brain as well as limit subdiaphragmatic hemorrhage.[10,13,14]

Emergency thoracotomy for blunt trauma has had very limited success. Uncertain findings, such as unexplained deterioration in the patient's hemodynamic and respiratory status, might cause one to consider an injury in a cavity that has not yet been explored.[15] Thus, in patients with blunt injuries to the chest, the history is particularly important and decisions for patient care must be individualized.

Cardiac injuries from blunt chest trauma usually are the result of high-speed MVAs. Falls from heights, crushing injuries from MVAs and falling equipment, blast injuries and direct violent trauma by assault are less common causes. The extreme end of the spectrum of blunt cardiac trauma belongs to the dramatic, often fatal, condition of cardiac rupture.[16] Early recognition, well-executed resuscitative efforts and prompt pericardial decompression are essential to improving survival following cardiac wounds, even in the patients presenting in extremis. Most authors agree that EDT for decompression of pericardial tamponade, cardiorraphy and control of exsanguinating hemorrhage has lowered mortality rates from thoracic trauma to some degree.[17,18] The indications for EDT are given in Table 4.[19] We define "no signs of life" for exclusion criteria of EDT as no detectable blood pressure, pupillary activity, respiratory effort, or cardiac electrical activity. In our series, four of six patients presented with blunt cardiac trauma, underwent EDT and none of them survived. One of the remaining two patients who underwent thoracotomy in the operating theatre, had cardiac tamponade due to a rupture in the ascending aorta and survived the operation, but expired in the intensive care unit on the sixth postoperative day. The other patient who had right atrial laceration survived to discharge.

The most common cause of blunt chest trauma is MVAs, accounting for 70 to 80% of blunt thoracic injuries.[20] Blunt forces applied to the chest wall cause injury by three mechanisms: rapid deceleration, direct impact

Table 4. Indications for emergency department thoracotomy

I. Clear indications
1. "Salvageable" postinjury cardiac arrest. Patients sustaining witnessed cardiac arrest with a high likelihood of isolated intrathoracic injury, particularly penetrating cardiac wounds.
2. Persistent severe postinjury hypotension (i.e., a systolic blood pressure <60 mmHg) due to:
   A. Cardiac tamponade
   B. Intrathoracic hemorrhage
   C. Air embolism

II. Relative indications
Refractory moderate postinjury hypotension (i.e., a systolic blood pressure <80 mmHg) due to:
A. Intrathoracic hemorrhage
B. Active intra-abdominal hemorrhage

and compression.[21] These traumas can cause not only localized fractures of the ribs, sternum and scapula, but also underlying injury to the lung paranchyma, myocardial contusion and hemopneumothorax and other injuries, such as diaphragmatic disruption, aorta and great vessels injury, intra-abdominal injury, orthopedic and neurosurgical problems. Pulmonary dysfunction observed after severe blunt thoracic trauma is probably secondary to underlying pulmonary contusion. Aspects of the patient's past medical history that are particularly significant include tobacco use, prior surgical operations and prior medical illness with metabolic (diabetes mellitus) and pulmonary conditions (chronic obstructive pulmonary disease). This information may clearly affect therapeutic decisions. Peripheral lung injuries can usually be repaired while central injuries and extensive pulmonary lacerations require lobectomy or pneumonectomy.[22]

Length of prehospital CPR was evaluated as a prognostic factor. A time of 5 minutes of prehospital CPR approaches the limits of viability in nonintubated trauma patients.[23] Aggressive endotracheal intubation has been associated with improved outcome in trauma patients,[24] particularly those with serious head injury or hemodynamic decompensation. Serious intrathoracic injuries, shock states or depressed neurologic function can all adversely affect spontaneous respiration or the compensatory mechanisms that maintain adequate pulmonary function during such conditions.[23] The best results were seen in these patients who were stable enough to undergo thoracotomy in the operating theatre and survived the operation. As our results indicate, early intubation may contribute to improved survival rates.

The results of EDT in our series were extremely poor compared with the results of other reports, mainly due to rapid deterioration of hemodynamic condition caused by severe cardiac injury. The outcome from emergency thoracotomy in the operating theatre was encouraging, due particularly to the patients' status being stable enough to be transferred to a fully equipped operating theatre. We emphasize the importance of emergency medicine education programmes on the rapid diagnosis of traumatic injuries with early intervention, and adequate hemodynamic and respiratory support. These educational courses should be undertaken by all emergency department and prehospital care staff.

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