

Patterns of Pediatric Thoracic Penetrating Injuries: a Single Trauma Center Experience – Riyadh, Saudi Arabia

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Abstract

Background

Trauma in pediatric age group is a major cause of morbidity and mortality. The causes and magnitude of pediatric trauma differs from region to region. Many studies have focused on blunt injuries but not on penetrating trauma. Our aim is to identify the patterns, and outcome of pediatric thoracic penetrating injuries in a single trauma center.

Methods

We conducted a retrospective chart review of pediatric patients who presented with thoracic penetrating injuries from the year 2001 till 2016 in a level 1 trauma center. Patients aged 18 years or less who presented to our emergency department with thoracic penetrating injury were included. Those transferred from other institutions were excluded

Results

The total number of patients included with penetrating thoracic injuries were 89. Mean age was 15.5 years. One female the rest were males. The most common mechanism of injury is stab wound by knives in 80%, then Gunshot in 12%. Main mode of transport to emergency department was by private vehicles in 75.3%. Type of injuries sustained were pneumothorax 70.7%, hemothorax 25.8%, diaphragmatic injury 5.6%, hemopericardium 4.49%, lung contusion and laceration 7.8%, cardiac injury 4.49%, major vessel injury 3.4%, pneumomediastinum 2.2%, esophageal injury 1.1%, and rib Fractures 1.1%. In the emergency department, endotracheal intubation required in 13.5%, chest tube insertion 73%, blood transfusion for resuscitation 16.8%, emergency thoracotomy 2.2%, pericardiocentesis 1.1%. Surgical intervention was required in 17%. Mean length of hospital stay 3.87 days \pm 4.86 SD. 93% of patients did not require intensive care unit admission. Mortality was observed in 3.4% were all had injuries to either heart, aorta or inferior vena cava.

Conclusion

In our institution, thoracic injuries were found uncommon and represent 25% of all penetrating trauma. Most sustained penetrating thoracic injuries can be managed nonoperatively safely. However, prompt resuscitation and intervention are required to identify and manage life-threatening ones.

Introduction

Trauma is a major cause of mortality and morbidity in all age groups. Globally, it is responsible for 9% and 6% of mortality and morbidity respectively [1]. Among children, trauma is the most common cause of

death [2]. Despite the fact that penetrating trauma is less frequent than blunt ones, penetrating injuries is associated with higher mortality regardless of age group [3-5]. Worldwide incidence of penetrating trauma varies from 10%–22% of all trauma cases [18-20].

Penetrating thoracic injuries have 4%-25% estimated risk of mortality among children [9]. Their anatomic and physiologic body differences put them at greater risk [3,9,10]. They have a relatively thinner chest wall and more vital organs compacted in a smaller area leading to an increased risk of organ injury with penetrating trauma compared to adults [3,10]. Also, children are more prone to tension pneumothorax and obstructive shock from any pneumothorax due to their mobile mediastinum [10,11]. Their tissues have higher rate of oxygen consumption, a lower functional residual capacity to their total lung volume ratio. As a result, they are more susceptible to hypoxia [10,11].

Many studies have focused on blunt injuries but not on penetrating trauma including thoracic. The prevalence, causes and magnitude of pediatric trauma differs from region to region. Our aim is to identify the patterns, characteristics and outcome of pediatric thoracic penetrating injuries in a single trauma center.

Material And Method

After obtaining an institutional review board (IRB) approval from king Abdullah international medical research center (KAIMRC), a retrospective chart review was conducted. The review was done in king Abdulaziz medical city (KAMC), a level 1 trauma center located at the central region in Riyadh, Saudi Arabia.

All patients aged 18 years or less that presented to emergency department (ED) with penetrating thoracic trauma from January 2001 till December 2016 were included. Those who were initially managed and transferred from other institutions were excluded. Data were collected by co-investigators including demographics, pre-hospital details, mechanism of injury, place of injury, mode of transport, duration from place of injury to arrival to ED, and initial ED admission data.

Data obtained from initial ED assessment till discharge including: type of injury, number of body regions injured, procedure performed in ED, operative intervention, length of hospital stay, length of intensive care unit (ICU) stay and mortality rate, and discharge status.

Collected data were entered into a data collection sheet and analyzed using Statistical Package for Social Science (SPSS®), Version 22.0 (IBM Corporation, Armonk, NY, USA). Quantitative variables presented as mean and \pm standard deviation (SD). Qualitative data presented as frequencies and percentages.

Results

The total number of patients who sustained penetrating trauma was 355 patients. Patients with chest penetrating injury were 89. Mean age was 15.5 years with \pm 3.6 SD. Male patients were 88 (98.9%) and 1

(1.1%) was a female. Intentional injuries were seen in 69 (77.5%) patients while 9 (10.1%) were unintentional.

The most common mechanism of injury (MOI) was stab wound by knives in 71 (79.8%) followed by gunshot injury in 11 (12.4%) and the remaining minority were air-gun, sharp objects and glass (Table 1). In most cases, the place of injury was not documented, however street was a common place of injury in 7 patients (7.9%). Private cars were the mode of transportation to ED in 67 (75.3%) patients, whereas ambulance in 21 (23.6%). The average duration from injury to ED arrival was less than 1 hour.

Isolated penetrating trauma to thoracic cavity was found in 58 (65.2%) patients, while the remaining were associated with other regions. The most common associated region were extremities in 16 (17.9%) followed by abdomen in 8 (8.9%). In 6 (6.7%) of thoracoabdominal injuries the peritoneum was violated and almost all, 5 (5.6%), had multiple organ injuries. The liver was the most common injured organ in 4 (4.5%) followed by stomach injury in 3 (3.4%). Most common type of thoracic injuries sustained were in following order pneumothorax in 63 (70.7%) patients, hemothorax in 23 (25.8%), lung contusion/laceration in 7 (7.8%) patients (Table2).

In ED, endotracheal intubation was required in 12 (13.5%) patients, chest tube insertion in 65 (73%), blood transfusion for resuscitation in 14 (15.7%), massive transfusion protocol only in 1 (1.1%), pericardiocentesis in 1 (1.1%) and emergency thoracotomy in 2 (2.2%). The majority were managed conservatively, operative intervention was required in 15 (17%). Thoracotomy was performed in 4 (4.49%) patients, median sternotomy in 1 (1.1%), thoracoscopy in 2 (2.2%), laparotomy in 5 (5.6%), diagnostic laparoscopy was performed in 2 (2.2%) patients. Wound exploration and closure in 1 (1.1%) patient. In 1 (1.1%), removal of bullet was performed by interventional radiology (IR) (Table 3).

Main indications for operative intervention for thoracotomy was for hemostasis, repair of lung and/or cardiac injury. Median sternotomy for evacuating pericardial hematoma. Thoracoscopy for hematoma evacuation and bullet removal. Combined laparotomy, median sternotomy and thoracotomy was performed in a patient with associated aortic and esophageal injury. Diagnostic laparoscopy for suspected diaphragmatic injury, one of which required conversion to open laparotomy due to associated abdominal/solid organ injury. laparotomy for solid organ injury associated with diaphragmatic injury repair.

Mean length of hospital stay was 3.87 days \pm 4.86 SD. In 83 (93.2%) patients, ICU was not required and were managed in regular wards. The average length of stay for those needed ICU was 6 days \pm 6.1 SD. Mortality was observed in 3 (3.4%). All had sustained injuries to heart, aorta or inferior vena cava. None has survived after emergency thoracotomy in ED.

Discussion

Penetrating thoracic injury has 4%-25% estimated risk of mortality among children [9]. This study aims to identify the patterns and characteristics of pediatric penetrating thoracic trauma in our region, Riyadh-

Saudi Arabia. Thoracic injuries secondary to penetrating trauma are uncommon representing 25% of penetrating trauma in pediatrics. Male patients were the predominating gender which is consistent with published studies [4,9,12,13]. Moreover, Stab wound secondary to knives was the predominating MOI in our region as shown in numerous studies from other regions [4,9,13,15]. In the contrary, Schechter S et al. showed that gunshot injuries were the most common MOI in pediatrics [21]. The mode of transport from site of injury to ED in the majority of patients was by private vehicles rather than by ambulance, which have been shown to be associated with lower mortality [22].

Two-third of patients had their penetrating injury isolated to their thoracic cavity. Pneumothorax being the most common injury encountered. The majority of patients were managed non-operatively. Operative management was required in 15 (17%). It may be attributed to higher percentage of low velocity injury in our reviewed cases. The percentage of operative intervention in other studies were 7%-44% [9,14-16]. In Our study the most common indication for operative management was due to diaphragmatic injury. 4 (80%) of all diaphragmic injuries were associated with intra-abdominal visceral/solid organ injury necessitating an abdominal approach for repair.

There are no clear well-established guidelines for utilizing ED thoracotomy as part of resuscitation in pediatric penetrating thoracic trauma yet. Few studies have attempted to address the outcome of ED thoracotomy in pediatrics. It appears that the younger the age of the victim, the less likely the survival rate. B. L. Beaver et al. reported 17 cases aged less the 14 years who underwent ED thoracotomy and none of the patients survived [17]. Also, M. L. Nance et al., reported no survivors after ED thoracotomy in 6 patient aged less than 17 years old [18]. In addition, N. M. Mollberg et al. similar death rate in 25 patients aged less than 18 years [9]. In H.B. Moore et al review, adolescents aged 15-18 years had a survival rate of 4.8% while none survived of patients aged less than 15 years [19]. Furthermore, C. J. Allen reported a 10% survival rate after ED thoracotomy performed in 128 penetrating trauma victims [20]. In our review, 2 (2.2%) patients underwent ED thoracotomy. Both were a victim of gunshot injury involving the inferior vena cava and/or the heart. both patients were able to be transferred to OR, none had survived.

Reported mortality rate in pediatric penetrating thoracic injury ranges from 4%-25% with mortality mainly related to great vessel/heart injury [9,14-16]. In our study mortality rate was 3.4%. Those patients who did not survive in our study had major vessel and/or cardiac injury secondary to a gunshot. All deaths were announced in OR.

This study is not without limitations. It is a retrospective study performed in a single center. Also, as one of the aims of the study was to address the injury settings including site, intent, perpetrator and socio-economic status in order to establish preventable measures of such injuries. However, during the review, there was inadequate data to enable analysis and inference to address such issues.

Conclusion

In our institution, thoracic penetrating injuries were found uncommon and represent 25% compared to the rest of body regions. It carries mortality of 3.4%. Most sustained penetrating thoracic injuries can be

managed non-operatively safely. However, prompt resuscitation and intervention are required to identify and manage life threatening ones.

Declarations

Acknowledgements

Not applicable.

Authors' contributions

All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by SA, and AH. Interpretation of data was discussed and prepared by MN, and JM. First draft of manuscript written by SA, AH. Revision of manuscripts by MN, and JM. All authors approved final manuscript.

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Competing interests

No conflicts of interest or **competing interests** associated with this publication

Consent for publication

Not applicable.

Availability of data and materials

Not applicable

Ethics approval and consent to participate

The study was conducted after obtaining an institutional review board (IRB) approval from king Abdullah international medical research center (KAIMRC), Riyadh, Saudi Arabia. Consent to participate is not applicable.

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Tables

Table 1: Pre-hospital Details:

| Pre-hospital Details | | Frequency (%) |
|---------------------------------------|--------------|---------------|
| Duration from injury to arrival to ER | < 1 hour | 39 (43.8%) |
| | 1 - 2 hours | 7 (7.9%) |
| | 2 - 6 hours | 1 (1.1%) |
| | Unknown | 42 (47.2%) |
| Mechanism of Injury | Gunshot | 11 (12.4%) |
| | Air Gun | 4 (4.5%) |
| | Stab-wound | 71 (79.8%) |
| | Sharp Object | 2 (2.2%) |
| | Glass | (1.1%) 1 |
| Place of Injury | Home | 3 (3.4%) |
| | School | 2 (2.2%) |
| | Street | 7 (7.9%) |
| | Unknown | 77 (86.5%) |
| Mode of Transport | Ambulance | 21 (23.6%) |
| | Private Car | 67 (75.3%) |
| | Unknown | 1 (1.1%) |
| Intentional Injury | Yes | 69 (77.5%) |
| | No | 9 (10.1%) |
| | Unknown | 11 (12.4%) |
| Total | | 89 (100%) |

Table 2: Type of Injury:

| Type of Injury | Frequency (%) |
|---------------------------|---------------|
| Pneumothorax | 63 (70.7%) |
| Hemothorax | 23 (25.8%) |
| Lung contusion/laceration | 7 (7.8%) |
| Diaphragm Injury | 5 (5.6%) |
| Hemopericardium | 4 (4.49%) |
| Cardiac Injury | 4 (4.49%) |
| Major Vessel Injury | 3 (3.4%) |
| Pneumomediastinum | 2 (2.2%) |
| Esophageal Injury | 1 (1.1%) |
| Rib Fracture | 1 (1.1%) |

Table 3. Operative approach:

| Operative approach* | Frequency (%) |
|-------------------------------|---------------|
| Thoracotomy | 4 (4.49%) |
| Median sternotomy | 1 (1.1%) |
| Thoracoscopy | 2 (2.2%) |
| Laparotomy | 5 (5.6%) |
| Diagnostic Laparoscopy | 2 (2.2%) |
| Wound Exploration and closure | 1 (1.1%) |
| Foreign body retrieval by IR | 1 (1.1%) |

*Multiple operative approach may have been used in the same patient.