

Pediatric thoracic trauma

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ABSTRACT

Objective: A retrospective analysis of the medical records of children up to 12 years of age inclusive, who sustained thoracic injuries during a 6-year period.

Methods: Ninety-one children were treated at King Fahad National Guard Hospital, Riyadh from January 1993 through December 1998. The clinical data included age, sex, mechanism of injury, associated injuries, pediatric trauma score, treatment and mortality.

Results: Eighty-seven children (96%) had injuries from blunt trauma and 4 from penetrating injuries. Of the blunt trauma cases, 82 children sustained motor vehicle accident related injuries, 62 as pedestrians and 20 as passengers. Penetrating thoracic injuries occurred in 4 children: 1 stab wound and 3 gunshots. The most frequent thoracic injuries were pulmonary contusion (70), pneumothorax (32), fractured rib (20) and fractured clavicle (18). Extrathoracic injuries included head (45), abdominal (41) and skeletal (26). Thoracotomy was required in only 1

child, laparotomy being necessary in 9 children for intraabdominal injuries. Tube thoracostomy was required in 33 children. Nine children died from motor vehicle accident related fatal head and neck injuries, 8 as pedestrians all with a pediatric trauma score ≤ 6 .

Conclusion: Thoracic injuries in children below 12 years of age are usually from motor vehicle accident related blunt trauma. Pulmonary contusion and pneumothorax are the most common thoracic injuries. Most thoracic injuries can be managed either conservatively or by tube thoracostomy. Thoracic trauma in children is an indicator of multisystem injury with head injury being the most common cause of mortality.

Keywords: Thoracic injuries, children, motor vehicle accident, blunt trauma.

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Thoracic trauma is relatively uncommon in children. The most frequent cause of pediatric thoracic injury is blunt trauma, which accounts for 85% of cases, 75% being motor vehicle accident (MVA) related.¹ In contrast, penetrating thoracic injuries are rare in children less than 13 years old.² Although, trauma is the leading cause of morbidity and mortality in children, the mortality from thoracic injuries is low and reported as 5-26%.³⁻⁵ It is usually the extrathoracic injuries rather than the thoracic injuries that are lethal. The present review was undertaken to examine our experience of pediatric thoracic trauma at our institution.

Methods. The clinical charts of all children up to 12 years of age inclusive, who were admitted to the

King Fahad National Guard Hospital, Riyadh from January 1993 through December 1998 with a discharge diagnosis of thoracic injury were reviewed. The clinical data obtained included age, sex, mechanism of injury, associated injuries, pediatric trauma score (PTS), treatment and mortality.

Results. There were 91 children, 66 males and 25 females; ages ranged between 5 weeks and 11 years (median 4 years). Eighty-seven children (96%) had injuries from blunt trauma and 4 (4%) from penetrating trauma (Table 1). Of the blunt trauma cases, 82 children sustained MVA-related injuries, 62 children as pedestrians and 20 as passengers. The ages of children who were auto-pedestrians ranged from 1 to 11 years (median 3.5 years) with a

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Table 1 - Mechanism of injury (number = 91).

Type of Injury	Number	Percentage
Blunt Injury	87	96
Motor vehicle accident		
Pedestrian	62	68
Passenger	20	22
Fall	1	1
Object	3	3
Fight	1	1
Penetrating Injury	4	4
Stab wound	1	1
Gunshot	3	3

Table 2 - Pattern of thoracic injuries (number = 91).

Type of injury	Blunt n =87 (%)	Penetrating n =4 (%)	Total
Pulmonary contusion	68 (78)	2 (50)	70 (77)
Pneumothorax	32 (37)	-	32 (35)
Hemothorax	2 (46)	-	4 (44)
Hemo-pneumothorax	-	2 (50)	2 (2)
Rib fracture	20 (23)	-	20 (22)
Clavicle fracture	18 (21)	-	18 (20)
Scapula fracture	2 (2)	-	2 (2)
Diaphragmatic rupture	1 (1)	-	1 (1)

Table 3 - Distribution of pediatric trauma score (number = 91).

Pediatric trauma score	Blunt	Penetrating
≤0	1	1
1 - 2	6	-
3 - 4	13	-
5 - 6	15	-
7 - 8	22	1
9 - 10	23	2
11 - 12	7	-

male to female ratio 3.4:1. For auto-passengers their ages ranged from 5 weeks to 10 years (median 5.5 years) and a M:F ratio 1.5:1. None of these children were restrained by seatbelts. The 4 children who were victims of penetrating thoracic trauma had ages ranging from 4 to 9 years (median 8.5 years) and M:F ratio 3:1. Seventy children sustained pulmonary contusion, 68 as a result of blunt trauma and 2 from penetrating injuries (Table 2). Other intrapleural injuries included pneumothorax, hemothorax and hemo-pneumothorax. Pneumothorax and hemothorax were seen in blunt trauma cases and hemo-pneumothorax in penetrating injuries. Tube thoracostomy was required in 27 children for pneumothorax whilst 5 children with occult pneumothorax were managed by observation only. Tube thoracostomy was necessary in the children with hemothorax and hemo-pneumothorax. Fractures of rib, clavicle and scapula were all the result of thoracic blunt trauma. There were no cardiac, esophageal or airway injuries. Only 1 child had a left diaphragmatic rupture. Multisystem injuries occurred in 81 children (89%). The lesions included 45 children (49%) with head injuries, 41 children (45%) with abdominal injuries and 26 children (29%) with skeletal injuries. Only 10 children (11%) had isolated thoracic injury. Thoracotomy was required in only 1 child with persistent bleeding from a tear in the thoracic aorta as a result of gunshot. Laparotomy was performed in 9 children for intraabdominal injuries; liver resection (2), liver repair (3), splenectomy (3), splenorrhaphy (1), nephrectomy (1), distal pancreatectomy (1), and left diaphragm repair (1). All the children with the exception of the last, underwent laparotomy due to persistent bleeding from the organ involved. Thirty-four children were intubated and mechanically ventilated; 3 for severe bilateral pulmonary contusion and 31 for severe head injuries. Bronchoscopy was necessary in 3 children for retained mucus plug.

The PTS of all children was calculated retrospectively by a formula incorporating the following physiologic variables on initial presentation: weight, airway, systolic blood pressure, central nervous system status, skeletal injury and severity of open wounds⁶ (Table 3). Thirty-two children (35%) had a PTS above 8 with only 2 (2%) being below zero. Fifty-seven children (63%) had a PTS range from 0 to 8. Nine children who died had a PTS ≤ 6 and their deaths were all related to lethal head injuries. The mortality rate was 10% and the lethal head injuries were all MVA-related injuries, 8 as pedestrians and 1 as an auto passenger. The male to female ratio was 2:1 and the median age 4.5 years (range 3-8 years).

Discussion. Trauma is the leading cause of death in children. Thoracic injuries are usually multiple and occur in 4-23% of pediatric trauma patients.^{5,7}

Blunt trauma is the most frequent cause of chest injuries in children. In a review by Al-Saigh et al, 80% of children less than 16 years of age sustained blunt trauma, 62% due to MVA.⁸ In our review though, 96% of the children were victims of blunt trauma, 90% being MVA-related. The majority of the children in both these reviews were auto-pedestrians. Poor driving, poor child care and children playing on the street are the main reasons for the injuries as pedestrians. Moreover, there were 8 children in our review whose relatives accidentally reversed their cars and drove over the children. Most children who were injured as passengers were thrown out of the vehicles. Seatbelt and child restraints are not compulsory in Saudi Arabia. It is common to see infants and children in the front passenger seats with no restraint or at the back of a pickup truck.

Penetrating thoracic injuries are usually uncommon in children less than 13 years of age.^{2,8,9} Since our review included children less than 12 years old, it is not surprising that only 4 children were victims of penetrating injuries. The 3 children who were shot were all accidental, whilst the only stabbing occurred during a fight. Children have a soft chest wall, which offers less protection to the underlying parenchyma. This allows direct transfer of energy to the underlying lung.³ Consequently; the most common injury is pulmonary contusion. Computed tomography (CT) scan has revolutionized the management of the multiple injured child. Although, a chest radiograph is necessary in the early assessment of the injured child, thoracic injuries may be either underestimated or overlooked. The higher resolution of CT scan makes it more sensitive in the detection of pulmonary contusion immediately after injury.⁵ Other injuries more accurately identified by CT scan include pneumothorax, hemothorax, and pulmonary laceration.^{5,10} However, thoracic injuries that require immediate treatment and for the patients with minor injuries and no respiratory symptoms, CT scan offers no advantage over a chest radiograph.¹¹ Pulmonary contusion has been reported as 30-75% in children following blunt trauma.^{1,2,12-14} In our review 78% of children following blunt trauma had pulmonary contusion from crashes and direct blow. Pulmonary contusion usually resolves within 7 to 10 days. It may however, be complicated by pulmonary infection, adult respiratory distress syndrome, chronic pleural effusion, pulmonary pseudocyst and death.¹² However in our cases, due to aggressive early intervention and therapy, none of these complications occurred. In 3 children who required intubation and mechanical ventilation for bilateral pulmonary contusion, only one child with retained mucus plug required bronchoscopy for bronchial toilette. Thirty-two children sustained pneumothorax from blunt trauma; 5 children whose pneumothorax was occult were observed with interval chest radiography without requiring tube thoracostomy.

The need for drainage of pneumothorax seen only on CT scan is currently unclear.¹⁰ None of these 5 children required mechanical ventilation and hence the chance of the pneumothorax progressing was slight. The other 27 children were treated immediately with tube thoracostomy without any complications. Ribs in young children tend to bend from impact rather than break as they are pliable. Rib fractures therefore, are less common and occurred in 23% of the children who sustained blunt trauma without flail chest. Rib fracture is considered an indicator of severe trauma and associated with significant mortality.⁷ However, only 20 children had rib fractures in this review, and there was no related mortality. The extrathoracic lesions can be as high as 72% in children.^{3,5,14} In 89% of the children in our series, there was an associated injury, the majority being related to the head and abdomen. The importance of associated extra thoracic injuries on mortality is emphasized by the fact that all 9 children died from lethal head injuries. Although isolated chest injury has a mortality of 5%, none of the children in this review died from purely thoracic injuries. This mortality increases to 20% if the abdomen is involved and to 35% if associated with head injury.^{3,5}

Pediatric trauma score is a combined anatomic and physiological index that predicts severity of injury and potential for mortality.^{6,15} Children with a PTS between 0 and 8 have an increased mortality unless there is appropriate and expeditious care. The mortality is 100% with PTS below zero. On the other hand PTS greater than 8 has a 0% mortality. Sixty-two percent of all the children in our review had a PTS between 0 and 8 and 2% below zero. The mortality rate in our review was 10% with all children's PTS below 6. With the range of PTS 1 to 6, the mortality in our review should have been 15% to 45%. The decreased incidence of mortality may reflect early aggressive management and timely intervention that was administered to these children and non-lethal associated injuries. Early resuscitative measures are necessary to avert mortality in thoracic trauma since it is usually associated with other injuries. Most thoracic injuries can be managed either non-operatively or by tube thoracostomy.¹⁶ Thoracotomy is required for persistent bleeding through chest tube, mediastinal injury or uncontrollable hemorrhage.^{2,8} Thoracotomy was required in one child who was shot through the chest and injured her thoracic aorta. This type of injury is infrequent in pediatric trauma.^{2,3} Most intraabdominal solid organ injuries are managed conservatively nowadays, the most common injuries being liver and spleen. For uncontrollable hemorrhage and hollow visceral injury laparotomy is required. Eight children underwent laparotomy for uncontrollable hemorrhage from solid organ injury and 1 child for left diaphragmatic repair.

In conclusion, most pediatric thoracic injuries are MVA-related with the majority of the victims being auto-pedestrians. The most frequent injuries include pulmonary contusion, pneumothorax and fractured ribs. Chest trauma is an indicator of multisystem injury and head injury is the common cause of death. There should be preventive measures aimed at preventing these MVA-related injuries. Programs should be instituted to improve street crossing skills of children using animated films, posters, public service announcements, and training sessions in real traffic situations or simulations.¹⁷ We agree with Stylianos and Eichelberger that, pediatricians and pediatric surgeons must act as child advocates in supporting and initiating legislative efforts at local and national levels aimed at reducing trauma-related childhood injuries and death.¹⁷ There should be a legislation in the use of seatbelts and car restraints for infants and children in Saudi Arabia.

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