

Original Research Article

Pediatric thoracic injuries-experience in a tertiary care centre

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ABSTRACT

Background: Isolated thoracic injury in children is not rare. Common modes of injury are blunt injury. As in children the chest wall is more compliant and the thickness of the subcutaneous and muscular layers is reduced, blunt trauma causes increased level of energy transmission leading to more chances of internal organ injuries whereas penetrating injury directly cause fatal injury to those vital organs causing significant mortality. In this study we are sharing our experience of managing isolated thoracic injuries in a tertiary trauma care centre with an encouraging outcome.

Methods: This prospective study was conducted in the department of pediatric surgery in NRS medical college and hospital, Kolkata during January 2019 to December 2021.

Results: Total no of cases with isolated thoracic injuries are 83 (Boys 50, girls 33). 64 children were treated conservatively and 19 required surgical intervention. 40% patients were between 2-6 years. Among the cases blunt trauma (82%), penetrating trauma (12%) and other mode of injuries (6%) have been noted which includes diaphragmatic rupture (2), bilateral hemothorax (2), unilateral hemothorax (10), pneumothorax (4), flail chest (2), isolated rib and clavicle injury (20), subcutaneous emphysema (4), tracheal injury (1), esophageal injury (1) and retained foreign body (3). Total 7 children required ventilatory support.

Conclusions: Management of isolated thoracic injury is done mostly by conservative management and few require intercostal drain placement. Thoracotomy is required rarely. Postoperative ventilatory support is also an important factor for managing such patients.

Keywords: Pediatric chest trauma, Penetrating trauma, Diaphragmatic injury, Esophageal injury, Tracheal injury

INTRODUCTION

Pediatric thoracic injuries occur in 4-6% of hospital trauma patients in isolation thoracic trauma carries 5% mortality and 25% mortality when combined with abdominal injury.¹ Blunt, penetrating and stab injuries are most common mode of injuries in children.^{2,3} Thoracic injuries in children occur more commonly due to non-penetrating trauma where most common cause may be due to automobile injuries and due to history of fall.⁴⁻⁷

Chest trauma is leading cause of mortality in childhood due to reduced resistance to the external blunt forces. In children the chest wall is more compliant and the

thickness of the subcutaneous and muscular layers is reduced. The increased level of energy transmission leads to more chances of internal organ injuries. Children have reduced functional capacity with higher oxygen consumption per unit body mass hence the major complication of chest trauma is hypoxia.^{8,9}

Chest trauma in children may be associated with abdominal trauma and should not be missed. So, in chest trauma patient's careful history taking and examination followed by proper investigation is required. Any patient of pediatric trauma presenting to the emergency should undergo a chest x-ray to rule out associated chest

trauma.^{10,11} In our study we have managed our patients following the ATLS guidelines.

Injuries to the chest wall, diaphragm, lungs and mediastinal structures occur in about 25% of children treated in level 1 pediatric trauma centers. Thoracic injuries usually occur following high energy blunt trauma/penetrating trauma. Change in velocity is strong predictor of significant injury for children in motor vehicle crashes.^{12,13}

The most common thoracic injuries are lung contusion, fracture rib, hemothorax, pneumothorax, injuries to the diaphragm, bronchi, aorta, heart are much less common but potentially more dangerous. The most common immediately life-threatening injuries to chest are tension pneumothorax, massive hemothorax and cardiac tamponade. The most common potentially life-threatening injuries to the chest are myocardial contusion, aortic disruption, ruptured diaphragm and tracheobronchial disruption. Esophageal rupture is rare.^{14,15}

Knowledge regarding pattern of pediatric thoracic trauma is essential for planning, implementation and management of trauma at initial level. This study is attempt to describe spectrum of presentations of chest and neck trauma in children, their modes of injury and type of intervention employed whether conservative/ surgical.

METHODS

Study population and duration

This is prospective study was conducted in the department of pediatric surgery in NRS medical college and hospital, Kolkata. The study was conducted from January 2019 to December 2021 among the pediatric population which included both boys and girls.

Inclusion criteria

All children under 12 years of age with isolated thoracic injuries were included in the study who were either conservatively managed or treated surgically were included in study.

Exclusion criteria

Patients associated with other system or organ injuries like head injury, abdominal injury were excluded. Associated spinal and vertebral fractures (NOT rib or clavicle fractures) also were not included in the study.

Management protocol

Initial resuscitation

All the cases of thoracic injuries were managed according to the advance trauma life support (ATLS) protocol. X-

ray chest and cervical spine was done for all cases for screening of thoracic injury and rule out cervical bony injuries respectively. E-FAST was done for poly-trauma patients. Other organ injury has been ruled out or managed accordingly.

Definite management of isolated thoracic trauma patients

The patients were managed according to the type of injuries which are as follows-intercostal chest tube (ICD) drainage, tracheostomy, local exploration and removal of foreign body, thoracotomy (removal of FB, repair of esophagus etc.), diaphragmatic rupture repair via abdominal route or conservative management by analgesia, antibiotics, chest physiotherapy etc.

Follow up

Patients were advised to follow up with repeat chest X-ray. In some cases, pulmonary function tests (PFT) are also advised to monitor post-operative pulmonary functions.

Sampling technique

Only thoracic trauma patients (Isolated thoracic injury) were included among all patients who attended pediatric emergency (age under 12 years) with trauma after initial resuscitation and screening USG and radiology. Other organ injuries involved were excluded as mentioned. Their management was followed up till discharge and even OPD follow up and data was tabulated.

Data collection and analysis

Data was collected from the OT register, bed head tickets (BHTs) and the departmental data register. The data was collected, analysed and tabulated using Microsoft excel software, 2010.

Ethical approval information

Ethical approval was not required but consent from parents/ guardians of all patients were taken in each cases before enlisting individual information and those who were not willing to take part in the study were excluded.

RESULTS

We have documented 83 cases of isolated thoracic injuries presented to emergency from year 2019-2021. Among them, 64 patients were treated conservatively and 19 needed surgical intervention- ranging from inter-costal drainage to thoracotomy (Figure 1).

Among all thoracic trauma patients boys were 50 and rest 33 were girls. 39 boys and 25 girls have been treated conservatively whereas 11 boys and 8 girls needed surgical interventions. Boys were found to be more in the study compared to girls (Figure 2).

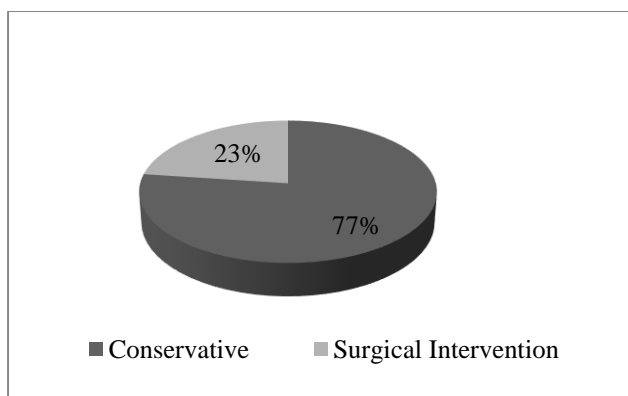


Figure 1: Isolated thoracic trauma patients distribution.

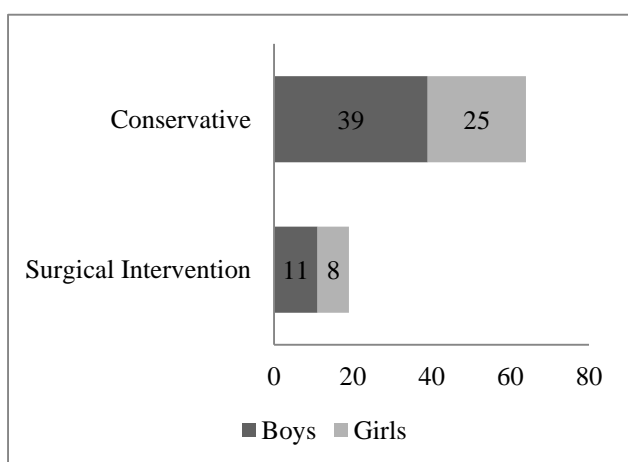


Figure 2: Sex distribution of thoracic trauma patients.

As the study was conducted in pediatric population (age less than 12 years), most commonly affected children were between 2-6 years of age which was 40% of the total cases. According to age distribution table number of children between age groups 0-<2, 2-<4, 4-<6, 6-<8 8-<10 and 10-12 were 9, 14, 19, 18, 13 and 10 respectively (Figure 3).

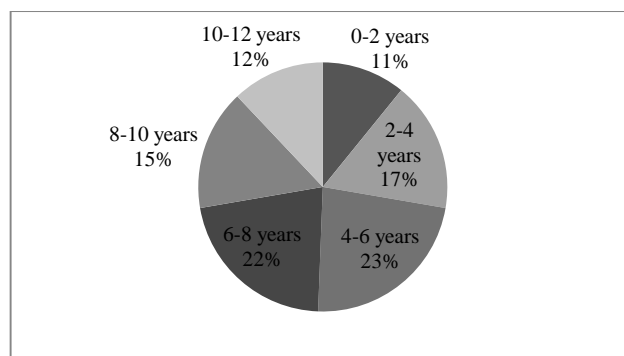


Figure 3: Age distribution.

Mode of injury of our patients were mostly blunt trauma (68) which is 83% and causes are road traffic accident, fall from height, fall of heavy objects, walls etc as stated by the parents/guardians. Only 10 children had penetrating trauma, 3 children with blast injury, 1 with gun-shot injury and 1 with retained foreign body (rod) (Table 1).

Table 1: Mode of injury.

Mode of injury	N	Percentage (%)
Blunt trauma	68	82
Penetrating trauma	10	12
Blast injury	3	3.6
Gun-shot injury	1	1.2
Other	1	1.2

According to tissue type most injury was soft tissue injury and bone injury-38 and 22 respectively which consisted 73% of all thoracic trauma patients and all were treated conservatively. Patients with subcutaneous emphysema (4) were followed up in ICU and those with flail chest (2) required ventilatory support for 1 day. isolated bony injuries and rib fractures were treated with analgesia and inspiratory spirometry along with deep breathing exercise (Table 2).

Table 2: Type of tissue and organ injury.

Type of tissue injury	Conservative management	Surgical management
Soft tissue	Subcutaneous lacerated or cut injury	0
	Subcutaneous emphysema	0
Bone	Isolated rib or clavicle fracture[#]	0
	Flail chest^{##}	0
Lung/ pleura	Unilateral hemothorax	6
	Bilateral hemothorax	2
	Pneumothorax	4
Diaphragmatic rupture	0	2
Esophageal injury	0	1
Tracheal injury	0	1
Foreign body	0	3
Total	64	19

*No diaphragmatic or great vessel injury was included in our study. # Single or multiple Rib fracture or Clavicle fracture not resulting other major organ injuries or bleeding (e.g., hemothorax). ## required mechanical ventilation.

In our study there were 10 patients with unilateral hemothorax (6 required inter-costal drainage), 2 cases of bilateral hemothorax, 4 cases of pneumothorax, 2 cases of diaphragmatic injuries (all were left sided diaphragmatic rupture and 1 case had a central tendon rupture associated with esophageal injury), 1 case each with esophageal injury and tracheal injury. Foreign body was found after

trauma in 3 cases which were iron rod (1) and stone chips following blast injury (2) (Table 3).

Among all patients of isolated thoracic injuries ventilatory support was required in 5 patients postoperatively and 2 patients with flail chest injury treated conservatively.

Table 3: Surgical procedures and post operative ventilation.

Type of injury	Surgical management	Ventilatory support	Remarks
Diaphragmatic injuries (2)	Abdominal exploration and repair of diaphragm	2	Uneventful recovery
Pneumothorax and hemothorax (12)	ICD drainage	0	One required thoracotomy
Tracheal injury (1)	Tracheostomy	1	Discharged with tracheostomy closure done as staged procedure
Esophageal injury (1)	Open repair of esophagus and gastrostomy	1	Discharged with gastrostomy, later gastrostomy tube was removed after securing oral feeding, following up in OPD-no stricture
Foreign body (2)	Thoracotomy and removal of foreign body	1	Uneventful recovery
Foreign body due to blast injury (1)	Local exploration and removal of splinter	0	Uneventful recovery
Total (19)		5	

DISCUSSION

Pediatric trauma patients are not very rare in tertiary care hospital emergency. Isolated thoracic trauma patients encountered 4-6% of all trauma patients.¹ In our study we have treated 83 cases of isolated thoracic injuries presented at our emergency from the year 2019-2021. In our study we excluded associated other organ injuries like abdominal or head injury and we did not encounter any mortality here. According to literature isolation thoracic trauma carries 5% mortality and 25 % mortality when combined with abdominal injury.^{2,3}

In our study most of them were treated conservatively (64 patients) only 19 required surgical interventions which includes 12 ICD placements, 5 thoracotomies and 2 Diaphragmatic rupture repairs by abdominal approach (Figure 4). Sami Gran and Gruvan et al conducted a study in turkey in children less than 18 years of age. Total no of cases taken were 225 among them 217 patients (60%) were treated conservatively and the eight patients were treated surgically.

Among our patients boys were found to be more in number compared to girls and most common age group is between 2-6 years. According to literature road traffic accidents and fall from height causing non-penetrating trauma are common causes in pediatric thoracic trauma cases.⁴⁻⁷ Age group between 2 to 6 is age for playing around and those children are vulnerable for the such trauma.

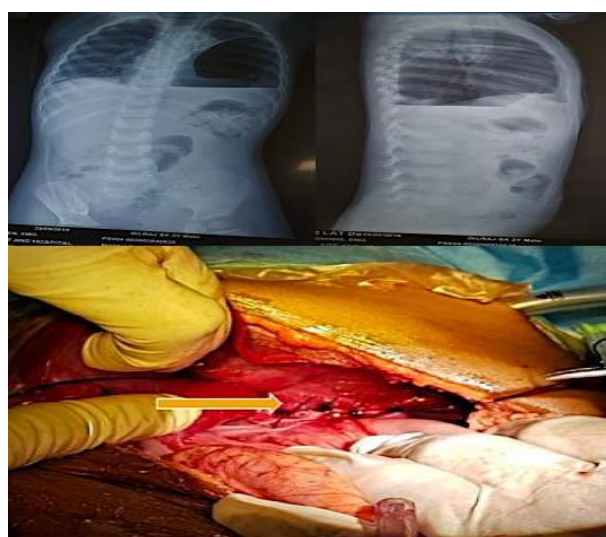


Figure 4: Thoracic trauma showing chest x-ray of diaphragm injury, (yellow arrow) repaired injury in diaphragm in abdominal approach.

Mode of injury of patients were mostly blunt trauma (68) which is 83% and causes are road traffic accident, fall from height, fall of heavy objects, walls etc as stated by parents/guardians. Only 10 children had penetrating trauma, 3 children with blast injury, 1 with gun-shot injury and 1 with retained foreign body (rod). Sami Gran and Gruvan et al in their study said the most common cause of injury was blunt trauma in 135 cases (60%), stab

injury in 67 cases (29.77%) and gunshot in 22 cases (9.77%).

According to tissue type most injury was soft tissue injury and bone injury-38 and 22 respectively which consisted 73% of all thoracic trauma patients and all were treated conservatively. Patients with subcutaneous emphysema (4) were followed up in ICU and those with flail chest (2) required ventilatory support for 1 day. Isolated bony injuries and rib fractures were treated with analgesia and inspiratory spirometry along with deep breathing exercise. There were 10 patients with unilateral hemothorax (6 required inter-costal drainage) all 2 cases of bilateral hemothorax and 4 cases of pneumothorax patients needed ICD insertion.

Keneally et al conducted a study in us military center where the mode of thoracic trauma was most commonly due to penetrating injury in 73.6% of cases. Pulmonary contusion was most commonly found in 45% of cases, pneumothorax in 40% of cases, rib and sternal fractures in 18% of cases.in his study mortality rate was 15.2%.¹⁶

Balci et al conducted a study in 137 children were mode of injury was most commonly due to blunt trauma. Pulmonary contusion was found in 68 cases (49.6%), rib fracture in 34 cases (24.8%), hemothorax in 25 cases (18.2%), pneumothorax in 18 cases (13.1%), post-traumatic effusion in 7 cases (5.1%), diaphragmatic rupture in 4 cases (2.9%), heart contusion in 3 cases (2.2%), flail chest in 3 cases (2.2%), tracheobronchial disruption in 2 cases (1.4%), lung laceration in 2 cases (1.4%), great vessel injury in 1 case (0.7%) and esophageal rupture in 1 case (0.7%).⁶

We found diaphragmatic injuries in 2 cases and all were left sided diaphragmatic rupture and 1 case had a central tendon rupture associated with esophageal injury. Diaphragmatic injuries occur most commonly in the left side because on the right side the liver acts as a protecting organ.¹⁸⁻²⁰ Diaphragmatic injuries were managed with abdominal exploration and repair of ruptured diaphragm. All patients required post-op mechanical ventilation and all of them had uneventful recovery (Figure 5).



Figure 5: Diaphragmatic injury-left hemidiaphragm (horizontal arrow) and central tendon (vertical arrow).

We found esophageal injury in 1 case which occurred due to stab injury by scissors while playing, patient presented to us with a complaint given by the mother there was discharge of milk and saliva from the wound. Patient had no respiratory distress; we further investigated the child with a chest x-ray and upper gastrointestinal contrast study. Esophageal injury is a very rare in thoracic trauma especially due to stab injury.²¹⁻²³ Esophageal injuries are associated with tracheobronchial injuries in 60% of cases and most commonly involved is the cervicothoracic part of esophagus.in esophageal injuries contrast radiographs have a sensitivity of around 97%.²⁵ Esophageal injury was managed with repair of esophagus and gastrostomy and feeding was started from the gastrostomy on post-operative day 2.

Tracheal injury occurred in 1 case due to cord around the neck, chest x-ray was done for this neonate which showed pneumo-mediastinum. Cunningham et al in his study mentioned 2 cases of tracheal injury which was caused during the exit procedure intrapartum and iatrogenically following intubation. The most common cause of tracheal injury is iatrogenic following endotracheal intubation specially in neonates.²⁶⁻²⁸ Tracheal injury was managed with tracheostomy and mechanical ventilation.

Foreign body was found in 3 cases which were iron rod (1) and stone chips following blast injury (2). Foreign body which was a iron rod was removed after thoracotomy (Figure 6) and foreign body due to blast injury was removed after local exploration of the wound. Luckily foreign body due to blast injury had no lung or pleura injuries.



Figure 6: Penetrating foreign body in lateral chest wall, chest x-ray and after removal by the thoracotomy.

Flail chest and subcutaneous emphysema were managed conservatively in 3 cases (14%).

In our study 5 cases required post-operative mechanical ventilation and 2 patients needed ventilator support for flail chest and later they were treated conservatively.

Limitations

In our study poly-trauma patients with multi-organ damage and more severe thoracic injuries were not included which were also managed. Their inclusion may have changed the dimension of result. To overcome these limitations more studies with paediatric poly-trauma cases is required in future.

CONCLUSION

Our study concludes that isolated thoracic injuries in paediatric age group is not rare and common in boys and between age group 2 to 6 years and organ or tissue damage occur mainly due to blunt trauma to the chest wall. Apart from blunt and penetrating trauma, blast and gunshot can also cause thoracic injuries and though tracheal injury occurs most commonly following endotracheal intubation cord around neck can also be a cause of tracheal injury. All patients of thoracic and neck injuries if managed according to the ATLS guidelines the mortality can be reduced further. A majority of isolated thoracic injury cases can be managed conservatively and surgical management to be targeted according to the underlying tissue or organ injury and among surgical options a limited patients require thoracotomy and ventilatory support.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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