RESEARCH PAPER

Profile of Injuries in Children: Report From a Level I Trauma Center

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Objective: We present our experience of pediatric injuries over 5 years from a level I trauma centre. **Methods**: De-identified data from a prospectively maintained database of pediatric patients was analyzed for demography and injury-related parameters, and management provided. **Results**: There were 906 patients (698 male, median age 12 years). Predominant cause was road traffic injuries. The median injury severity score was 9. Abdomen and thorax were the commonest regions affected. There were 44 deaths. Sepsis and hemorrhage were the commonest causes of mortality. **Conclusions**: The magnitude of pediatric injuries is significant, and maintenance of dedicated trauma registries is the need of the hour.

Keywords: *Epidemiology, Injuries, Management*, *Unintentional.*

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Trauma is one of the leading causes of death and disability worldwide. More than 90% of injury related deaths occur in low and middle-income countries (LMICs) where preventive efforts are largely non-existent and the health care systems are poorly equipped [1]. Owing to poor registry, the epidemiology of pediatric injuries is difficult to estimate in LMICs [2].

We conducted this study to appraise various parameters of injured pediatric patients, so as to provide baseline information for further research, effective management and planning of preventive strategies for pediatric trauma patients in the country.

METHODS

The study was conducted at a high volume Level I trauma centre in India. All patients are managed using Advanced Trauma Life Support (ATLS) protocol [3]. Inpatient data from January, 2012 to September, 2017 was collected and de-identified using a unique health identification number, in a prospectively maintained computerized database. Patients aged 18 years or less were included. Age, gender, mechanism of injury, findings of primary and secondary survey, region-wise distribution of injuries, hospital stay and mortality was recorded. The data were entered in a pre-designed performa and analyzed using SPSS version 25. The data were summarized using percentage, median and mean.

RESULTS

There were 906 patients (77% males) with median (IQR) age of 12 (7-17) years. Majority (n=440; 48.6%) belonged to 13-18 y age group, followed by 7-12 y (n=216; 23.8%) and 4-6 y (n=120; 13.2%); toddlers constituted 11.7% of the cohort (n=106). Road traffic injury (RTI) was the commonest cause of trauma (47.4%) (**Table I**).

Airway was found threatened or compromised in 72 (7.9%) patients. Breathing was compromised in 92 (10.2%). Focused assessment sonography in trauma (FAST) was positive in 294 (32.5%) patients. Glasgow coma scale (GCS) score was subnormal at presentation in 149 (16.4%) patients. Isolated trauma, defined as injury to one abbreviated injury score (AIS) region only was found in 445 (49.1%) patients, whereas 461 (50.9%) had polytrauma. Median (IQR) Injury Severity Score (ISS) was 9 (4-13).

We had 63 patients with head injury, 14 with neck and 80 patients with maxillo-facial injuries (**Web Table I**). Two hundred thirteen (23.5%) patients had chest trauma, majority of them (196, 92%) were managed non-operatively; 90 patients required insertion of an ICD tube (**Web Table II**). Four patients presented with cardiac tamponade, requiring urgent thoracotomy.

There were 370 (40.8%) patients of abdominal trauma, with 351 (94.9%) having blunt trauma while rest had penetrating injuries. Ninety-three percent (188/202) liver and 71.1% (64/90) splenic injuries were successfully managed non-operatively. We had 78 patients of pelvic injuries, all but one due to blunt trauma; 37 (47.4%) of them required operative intervention for associated abdominal injuries and/or pelvic fixation (**Web Table III**).

TABLE I Mechanism of Trauma and Causes of Death in Pediatric Inpatients (<18y) With Trauma (*N*=906)

Characteristic	*n (%)*
Mechanism[a]	
Road traffic injurty	429 (47.4)
Railway track injury	13 (1.4)
Fall from height	81 (8.9)
Blunt assault	46 (5.1)
Gunshot	16 (1.8)
Stab injury	26 (2.9)
Unknown	59 (6.5)
Self-inflicted	15 (1.7)
Accidental/sports	192 (21.2)
Machine injury	14 (1.5)
Cause of death (n=44)	
Sepsis	21 (47.7)
Hemorrhagic shock	15 (34.1)
Head injury	5 (11.4)
Arrythmia	1 (2.3)
Cardiac arrest	1 (2.3)
Not known	1 (2.3)

[a]*Fall of object on patient (n=6), animal injury (n=4), foreign body ingestion and blast injury (2 each) and electrocution (n=1) were other causes of injury.*

There were nine children with vascular injuries in torso including one internal mammary artery (IMA), one inferior vena cava and one hepatic artery injury. All were repaired except IMA which was ligated. Six patients had pseudoaneurysm of various abdominal vessels that were coil embolized. In extremity vascular trauma, we had 63 arterial and 2 venous injuries in 53 patients. Mode of trauma was sharp in 15 (28.3%) and blunt in rest. All of them underwent various standard surgical procedures (**Web Table IV**). There was no amputation.

Soft tissue injuries were seen in 132 patients (**Web Table V**). There were 14 nerve and 15 tendon injuries, all were repaired primarily. There were 157 extremity fractures, 6 dislocations, 11 traumatic amputations, 14 mangled extremities, 33 crush injuries and 9 compartment syndromes in 158 patients. One hundred four (65.8%) patients required operative management and rest were managed non-operatively. There were 27 patients with spine injuries; 15 (55.6%) were managed with surgery.

Discharge to home care was possible in 862 patients (95.1%). There were 44 (4.9%) deaths. The commonest cause of mortality was sepsis followed by hemorrhagic shock and head injury (**Table I**).

DISCUSSION

Almost half of our patients were less than 12 years of age. It has been reported that the most common pediatric age group affected by injury is 6-12 years [4]. Male to female ratio in our study was 3.36:1, which is in agreement with the published literature [5]. Some investigators have found home to be the most frequent place of injury [6] whereas, similar to our findings, others report RTI as the most common cause [1,5]. Fall from height has been cited as the commonest mechanism of trauma in pediatric age group by various authors [7,8]. We did not find similar result; this could be due to exclusion of neurosurgical patients, as majority of children sustaining fall from height suffer head injuries and are therefore likely to be admitted under care of neurosurgeons.

Most of the children with chest injuries were successfully managed non-operatively with insertion of ICD in select patients. Similar findings have been reported by other authors too [9,10]. This supports that majority of such patients can be managed at centres having basic resources and a team who can care for an injured child. Our experience with traumatic cardiac injuries also reinforced the importance of trauma management protocols in place. We could identify all patients with cardiac tamponade based on mechanism of injury, vital signs and findings of FAST alone. All of them were operated by trauma surgeons without cardiopulmonary bypass with good results.

We could manage majority of solid visceral injuries with close monitoring alone, as also reported previously [9,10]. This can be accomplished with basic resources like a facility for close observation, blood bank and operation theatre, or a robust referral system to an equipped facility. Similarly, all our patients with extremity vascular injury were managed by trauma surgeons with good outcome. Good functional outcome of vascular injuries managed by general surgeons have been reported by others too [11]. Most of the patients with soft tissue injury were managed non-operatively. Early and aggressive treatment of soft tissue injuries in children have been emphasized by other authors as well [12,13].

The mortality rate in our cohort was 4.9%, which is lower than the Western data [14] and that from elsewhere in India [9]. One reason for the low mortality rate in our study may be the exclusion of neurosurgical patients as up to 85% of deaths have been reported due to head injuries in pediatric patients [15]. However, we believe that an organized approach by a committed team with appropriate resources is able to achieve better outcomes. Better outcome has been reported by many other authors following standard trauma protocols [1].

WHAT THIS STUDY ADDS?

- This study on 906 injured children gives a comprehensive account of demography, profile and outcome of pediatric inpatients with injuries.

Limitations of this study include exclusion of patients admitted under neurosurgery and orthopedics; including them could have brought our results closer to actual burden of pediatric trauma in our setting. The single-center data and inclusion of only inpatients also precludes generalization of these findings.

Results comparable to dedicated pediatric trauma centers can be achieved by adopting an organized and protocol-based approach to trauma care. Maintenance of dedicated trauma registries is the need of hour. However, the goal of all studies on pediatric trauma will be fulfilled only when injury prevention strategies are effectively implemented.

Contributors: AR: conceptualized the study, revised the draft critically for important intellectual content, MKJ:acquisition, analysis and interpretation of data for the work, drafted the work and revised it critically for important intellectual content, BM, SK, SS:substantially contributed to the design of the work, revised the manuscript critically for important intellectual content, AG:acquisition and interpretation of data, substantially contributed to the design of the work, revised the manuscript critically for important intellectual content. All authors approved the final version to be published and are accountable for all aspects of the work.

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Web Table I Head, Neck, Face and Maxillofacial Injuries in Pediatric Inpatients With Trauma (*N*=157)

Anatomic region	*Breakup of Injuries*	*Operative*	*Non-operative*
Head (*n*=63)			
Parenchymal	25	0	63
Bony injury	24		
EDH	8		
SDH	7		
SAH	4		
Neck (*n*=14)			
Cervical trachea	10	5	5
Cervical esophagus	3	1	2
Cervical vascular injury	4	1	
Spinal/ vertebral/ bony	1		
Muscular	1	1 (muscle repair)	
Thyroid	1		
Face and maxillofacial (*n*=80)			
Mandibular injury	50	ORIF	54
Extra mandibular	57	Orbital floor	1
bony injury		repair	
Eye/ear	6/1	FTP fasciocutaneous flap	1
		SSG	2
		Ex Fix	1

EDH:extradural hemorrhage; SDH: subdural hemorrhage; SAH: Subarachnoid hemorrhage; ORIF: open reduction and internal repair; SSG: split skin graft; FTP: frontotemporoparietal.

Web Table II Chest Injuries in Pediatric Inpatients With Trauma (*N*=213)

Finding/ organ injured	*No.*	*Operative*	*(n=17)*
Pneumomediastinum	6		
Subcutaneous emphysema	9		
Rib fracture	67		
Hemopnemothorax	32		
Pneumothorax	64	Thoracotomy[a]	2
Hemothorax	36	Thoracotomy[a]	4
		VATS[b]	1
		Thoracotomy[b]	2
Lung contusion	50		
Thoracic tracheal injury	12	Thoracotomy[c]	
	2		
Esophagus injury	2	Thoracotomy[c]	1
Chylothorax	1		
Blunt cardiac injury	2	Thoracotomy	2
Penetrating cardiac Injury	2	Thoracotomy	2
Great vessel injury (SVC)	1	Sternotomy (SVC)	1
Overall ICD use in chest trauma non operative management (n=196)			
Without ICD	106		
With ICD	90		

[a]massive or [b]retained hemothorax;[c]Posterolateral thoracotomy. ICD: intercostal drain; SVC: superior vena cava; VATS: video-assisted thoracoscopic surgery.

Web Table III Abdominal, Pelvic, and Genitourinary Trauma in Pediatric Inpatients (*N*=370)

Organ	*Break-up/AAST Grade*	*No.*	*Operative*	*No.*	*Non-operative, no.*
Diaphragm (*n*=7)			Primary repair	6	1 (right side)
Spleen (*n*=90)	1	11	Splenorrhaphy	2	64
	2	24			
	3	26			
	4	23	Splenectomy	24	
	5	6			
Liver (*n*=202)	1	21	Peri-hepatic packing	13	188 (1 AE)
	2	36			
	3	52	Packing + angioembolization (AE)	1	
	4	78			
	5	15			
Kidney (*n*=55)	1	2			51 (Pigtail for urinoma- 8)
	2	12			
	3	14			
	4	20	Nephrectomy	4	
	5	7			
Hollow viscus (*n*=26)	Stomach	0	Repair+RD+FJ	3	1 (mesenteric tear)
	Duodenum	1	Primary repair	11	
	Jejuno-ileal	10	Resection anastomosis	4	
	Large bowel	12	Stoma		17
	Mesenteric	3	Laprotomy	7	
Pancreas (*n*=3)	1	1			1
	2	0			
	3	0			
	4	2	Distal Pancreatectomy	2	
	5	0			
Biliary system (*n*=2)	Blunt trauma		1		1 (AE for hemobilia)
Perineum (*n*=11)[a]	Penetrating injury	3		10	1
	Blunt	8			
Genitourinary (*n*=14)	Ureter	1	Primary repair	1	0
	Urethra	4	Suprapubic cystostomy	4	0
	Male genitalia	2		2	0
	Female genitalia	7		3	4
	Urinary bladder				
	Extraperitoneal	2	Bladder neck repair	1	1
	Intraperitoneal	4	Primary repair	4	0
Pelvis (*n*=78)			Packing +/- ExFix	37	41
Great vessels (2)	IVC	2	Primary repair	1	1

[a]*Associated injuries: bowel-8, urethra-2. AAST-American Association for the Surgery of Trauma.*

Web Table IV Peripheral Vascular Injuries in Pediatric Inpatients With Trauma (*N*=65)

Vessel	*Embolectomy*	*Repair*	*End-to-End anastomosis*	*Interpostition vein graft*	*Ligation*
Brachial(*n*=25)	5	7	8	5	0
Ulnar (*n*=14)	2	5	4	1	2
Radial (*n*=12)	1	6	4	1	0
Femoral (*n*=7)	2	1	3	1	0
Popliteal (*n*=5)	1	0	3	1	0
External jugular veins (*n*=2)	0	0	0	0	2

Values in no.

Web Table V Soft Tissue Injuries in Pediatric Inpatients With Trauma (*N*=132)

Organ	*No.*	*Operative*	*No.*	*Non-operative, no.*
Peripheral nerves	14	Primary repair	14	0
Tendon	15	Primary repair	15	0
Skin and subdermal tissue trauma		*Procedures done*		
Abrasions	3	Debridement	95	8
Lacerations	53	Primary/delayed primary closure	57	
Degloving injuries	38	Split skin graft	41	
Incised wounds	4	Flap coverage	8	
		Vacuum assisted closure	2	
Region-wise location of soft tissue trauma				
Head and neck	20			
Orofacial	26			
Thorax	6			
Abdomen/perineum	11			
Extremity/shoulder/pelvic girdle	49			