Clinical features and treatment of thoracic trauma in children.

Eleven years of experience in a single center

Ann. Ital. Chir., 2023 94, 4: 351-357
pii: S0003469X23038915

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Clinical features and treatment of thoracic trauma in children. Eleven years of experience in a single center.

AIM: *This study aims to evaluate the characteristics of thoracic trauma in children.*
MATERIAL AND METHOD: *Thoracic trauma cases treated in our clinic between February 2011 and January 2022 were retrospectively analyzed.*
RESULTS*: 31.5% (n=136) of 432 cases with thoracic trauma had isolated thoracic trauma. Mean age was 8.7±4 years, 74.3% were boys (n=321) and 25.7% were girls (n=111). In patients with thoracic trauma in children; blunt injuries were 84%, penetrating-stab wounds were 12%, and gunshot wounds were 4%, while the rate of penetrating trauma over the age of 15 was 24.8%. The most common causes were motor vehicle accidents (42.4%) and falls from height (23.9%). The most common pathologies; pulmonary contusion (71.7%), pneumothorax (48.7%), rib fracture (18%), and pulmonary laceration (12%). Tube thoracostomy was performed in 51 (46.4%) of 110 cases with pneumothorax. Thoracotomy was performed in 2 cases with penetrating gunshot wounds, and tube thoracostomy was performed in 2 cases with hemothorax. The mean hospital stay was 7 days, and1 case with severe cranial trauma died.*
CONCLUSION: *Chest wall, pulmonary, mediastinal, and diaphragmatic structures can be damaged in chest trauma. However, it should be kept in mind that every chest trauma patient may also have polytrauma, and accompanying injuries should be carefully examined.*

KEY WORDS: Childhood, Thoracic trauma, Tube Thoracostomy.

Introduction

Trauma-related deaths take first place among the causes of child death in developed countries [1]. Thoracic traumas are the second most common cause of trauma-related death in children. Mortality in thoracic traumas alone is 4%. As with all other pediatric traumas, blunt traumas are more common than penetrating traumas [1]. Thoracic injury is the second leading cause of death in traumatized children especially aged 1-4 years, and the leading cause of death in children older than 4 years. Mortality in thoracic traumas alone is 4%. As with all other pediatric traumas, blunt traumas are more common than penetrating traumas [1]. Among the causes of trauma, falls are the most common cause of admission to the emergency department in all age groups [2], and it is the second most common cause of death after motor vehicle accidentsn[3]. Although the falls seen in the pediatric age group are mostly accidental and can be prevented with some precautions, they are still an important cause of morbidity and mortality. Careful evaluation of children with thoracic trauma is imperative, as thoracic injuries are a reliable predictor of the severity of injury in children. If these in are not detected and treated appropriately, the morbidity risk of children is 50% or more imjurpes [3,4].
Multisystemic injury is found in more than 50% of children with thoracic injuries most of which are secondary

Pervenuto in Redazione Settembre 2022. Accettato per la pubblicazione Maggio 2023
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to blunt traumas. Children have some distinctive anatomic and physiologic properties of the respiratory system from adults, so these require different management. The pediatric thorax has a greater cartilage content and incomplete ossification of the ribs.
Due to the elasticity of the pediatric rib cage and mediastinal mobility, a remarkable intrathoracic injury may exist in the lack of external signs of trauma. Approximately one hundred and forty deaths related to falls in the age group of 15 and under are seen in the United States of America each year, and more than three million children apply to the emergency department (ED) due to falls [5].

Material and Method

This research was performed in accordance with the Helsinki Declaration and with the approval of the local ethics committee (Clinical Ethics Committee, date 27.04.2022, issue 04-2022/05). It is a retrospective study, and of the 492 patients included in the study, 60 of them had missing file information, so 432 were included in the study admitted to our training and research hospital ED between February 2011 and January 2022 were analyzed. Cases diagnosed with thoracic trauma were evaluated in terms of demographic data, etiology, clinical and radiological features, and treatment results. Each patient and/or their parents were informed in advance of the interventions and investigations. Those with indications were evaluated with thorax computerized tomography. Pathology was confirmed by thoracentesis in cases with suspected hemothorax. The diagnosis of concomitant organ injuries was made by consultation of the relevant clinics with extremity graphics, brain tomography, brain MRI, abdominal US, and abdominal tomography.
Today, in many countries of the world, the pediatric trauma score (PTS) is used to reveal the state of children after trauma. It is the combination of anatomical and physiological data such as the patient's weight, airway condition, systolic blood pressure, central nervous system, open wound, and bone fracture.
It is suggested that PTS correlates with the severity of trauma. Pediatric Trauma Score (PTS) ranging from + 12 to – 6 values™ was determined for each patient 6 Patient records were reviewed retrospectively, distribution of trauma forms a seasonal relationship between trauma, developing thoracic pathologies, and other accompanying system injuries, surgical treatment methods applied, and hospital stay duration (hsd) were evaluated in terms of complications and mortality.

Table I - *Clinical and surgical aspects.*

	Group of Junior Surgeon (N = 49)	Group of Senior Surgeon (N = 56)	P value
Gender			
Male	41 (83.67)	52 (92.86)	0.4008
Female	8 (16.32)	4 (7.14)	0.4008
Age			
Young adults	9 (18.37)	18 (32.14)	0.2126
Middle aged adults	27 (55.10)	23 (41.07)	0.2104
Older adults	13 (26.53)	15 (26.79)	0.9842
Average age	50.78	49.92	-
Nature of abdominal wall defect			
Primary	47 (95.92)	48 (85.71)	0.3462
Recurrent	2 (4.08)	8 (14.29)	0.3462
Localization of abd. wall defect			
Right	27 (55.11)	19 (33.93)	0.0587
Left	17 (34.69)	18 (32.14)	0.8210
Bilateral	5 (10.20)	19 (33.93)	0.0309
Type of abdominal wall defect			
Direct	11 (22.45)	10 (17.86)	0.6786
Indirect	26 (53.06)	34 (60.71)	0.4951
Mixt	12 (24.49)	12 (21.43)	0.7838
Durations of surgery			
Short (< 60 minutes)	30 (61.23)	35 (62.50)	0.9114
Intermediate (60 – 90 minutes)	14 (28.57)	2 (3.57)	0.0232
Prolonged (> 90 minutes)	5 (10.20)	19 (33.93)	0.0309
Postoperative complications			
Hemorrhage	0 (0)	1 ()	-
Abscess	0 (0)	2 ()	-
Trocar hematoma	2 ()	0 (0)	-

Young adults:18-40 years; Middle aged adults:41-60 years; Older adults: >60 years.

Statistical Analysis

Descriptive statistics for PTS and HKS are expressed as median value (Median), mean, standard deviation, and minimum and maximum value. The Kruskal-Wallis test was used to determine whether there was a difference between the groups for this feature. In the calculations, the statistical significance level was taken as 5% and the calculations were made in the SPSS statistical package program.

Results

In this study, 136 (31.5%) of 432 cases with thoracic trauma had isolated thoracic trauma. Mean age was 8.7±4 years, 71.2% were boys (n=321), 28.8% were girls (n=111). In patients with thoracic trauma in children; blunt injuries were 91.2%, penetrating-stab wounds were 7.9%, and gunshot wounds were 0.9%, while the rate of penetrating trauma over the age of 15 was 10.8% (Table I). The most common causes were motor vehicle accidents 216 (50%) and falls from height. Tube thoracostomy was performed in 51 (46.4%) of 110 cases with pneumothorax. Thoracotomy was performed in 4 cases with penetrating gunshot wounds, and in 2 cases with hemothorax.

The mean hospital stay was 7 days, and 1 patient with severe cranial trauma died. Rib fractures were seen in 44 (10.2%) patients with thoracic trauma; 14 (3.24%) of these rib fractures had hemothorax, and 18 (4,17%) had lung contusion (Table II).

In the statistical comparison of the cases in terms of PTS, the number of cases with thoracic trauma + faciyal trauma + head trauma and thoracic trauma+eye injury+head trauma and thoracic trauma + spinal trauma was two, so excluded from the comparison.

There was no statistical difference between cases with isolated thoracic trauma and cases with accompanying orthopedic trauma and abdominal trauma accompanying thoracic trauma (Table III).

PTS was found to be significantly lower in all cases with head trauma accompanying thoracic trauma compared to the other groups, and the difference between them was statistically significant (p=0.002). The lowest mean PTS was found in the group with thoracic trauma together with head trauma, and orthopedic and abdominal trauma (Table IV).

In the evaluation made in terms of HKS, in cases with head trauma accompanying thoracic trauma, with or without other system trauma, HKS is significantly prolonged and the difference between them is detected as statistically significant (p=0.001).

A total of 7 cases died, including 4 (0.93%) patients with a mean PTS –1, +1, +1, +2, with the thorax, head, abdomen, and extremity trauma, 2 (%0.46) of them with a mean PTS +1, +2 with the thorax, head, and spinal trauma, and 1 (%0.23) of them with a mean PTS +1

Table II - *Pain sensation in different postoperative periods.*

	Group of Junior Surgeon (N = 49)	Group of Senior Surgeon (N = 56)	P value
Immediate postoperative period			
Complained about pain	49 (100)	56 (100)	-
Nature of accused pain			
Persistent	27 (55.11)	33 (58.92)	0.7342
Intermittent	15 (30.61)	18 (32.15)	0.8929
Irradiating	7 (14.28)	5 (8.93)	0.6247
Average Pain Index I	20.87	21.51	0.4054
Average antalgic treatment (day)	2.20	2.17	0.9854
Early follow up			
Complained about pain	28 (57.14)	40 (71.42)	0.2010
Nature of accused pain			
Persistent	10 (35.72)		12
(30)	0.7927		
Intermittent	17 (60.71)	27 (67.5)	0.6127
Irradiating	1 (3.57)	1 (2.5)	1.0000
Average Pain Index II	5.73	5.80	0.4510
Late follow up			
Complained about pain	18 (36.73)	11 (19.64)	0.1245
Nature of accused pain			
Persistent	1 (5.56)	2 (18.18)	0.5394
Intermittent	17 (94.44)	9 (81.82)	0.5394
Irradiating	0 (0)	0 (0)	-
Average Pain Index III	1.65	1.55	0.2191
Resuming physical effort			
Average (weeks)	4.25	4.19	0.4018

TABLE III - *Surgeon and postoperative pain relationship – Group statistics*

	Surgeon type	N	Mean	Std. Deviation	Std. Error Mean
Immediate postoperative pain (Pain Index I)	Senior surgeon	56	21.52	5.288	.707
	Junior surgeon	49	20.88	7.721	1.103
Early follow up pain (Pain Index II)	Senior surgeon	56	5.80	6.708	.896
	Junior surgeon	49	5.73	7.402	1.057
Late follow up pain(Pain Index III)	Senior surgeon	56	1.55	4.740	.633
	Junior surgeon	49	1.65	3.800	.543

TABLE IV - *Surgeon and postoperative pain relationship – Independent Samples Test*

		Levene's test for equality of variancest		t-test for equality of Means					95% confidence interval of the difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Im. postoperative period (Pain Index I)	Equal var. assumed	9.859	.002	.501	103	.618	.640	1.278	-1.895	3.176
	Equal var. not assumed			.489	83.25	.626	.640	1.310	-1.965	3.246
Early follow up (Pain Index II)	Equal var. assumed	1.452	.231	.050	103	.960	.069	1.377	-2.662	2.800
	Equal var. not assumed			.050	97.73	.960	.069	1.386	-2.682	2.820
Late follow up (Pain Index III)	Equal var. assumed	.324	.571	-.118	103	.907	-.099	.847	-1.778	1.579
	Equal var. not assumed			-.119	102.25	.905	-.099	.834	-1.754	1.555

with thorax, head, abdominal, extremity trauma Mortality rate was determined as 1.63% with 7 cases. The cause of mortality was determined as an acute subdural hematoma in three trauma cases, acute epidural hematoma in two trauma cases, and intracerebral hematoma and splenic rupture in two cases. A rib fracture with hemothorax in four patients with acute subdural hematoma, and a rib fracture with hemopneumothorax in the other three cases were thoracic pathologies. All patients who died due to intracerebral and subdural hematoma had a pulmonary contusion.

Discussion

Although thoracic trauma statements for only 5-12% of acceptances to a trauma center, it is second only to head injury as the most common cause of death in patients younger than 18 years [7]. Thoracic traumas in the pediatric age group are considered dissimilar from those in adults with regard to both anatomic properties and trauma installations. In the study by Şentürk et al (2010) considering adults, they declared that 73% of the cases were males. Similarly, Ismail and Al-Refaie (2012) declared that 79.2% of pediatric patients with thoracic traumas were males. In our research, 71.2% of the patients were males, which is compatible with the results in the literature. The most common type of thoracic trauma is rib fractures, as in virtually all presentations [8].

Since the jeans in children are less mineralized and more flexible than in adults, the jeans usually stretch and do not break during thoracic trauma. The rate of rib fracture observed in 11 cases (23.42%) in our series is in line with the data in the literature [9]. The flexibility of the rib cage in the pediatric age group directly reflects the energy generated during trauma to the lung parenchyma and causes parenchymal damage. Pulmonary contusion is a very common condition in the posttraumatic period [10]. In this study, isolated or combined lung contusion developed in 21 (44.68%) cases, which is consistent with the literatüre data.

Tube thoracostomy continues to be the most commonly used method for treatment approaches in chest trauma. In our research, tube thoracostomy was performed in 42 (30.9%) cases with impaired pleural integrity. However, this rate is much higher (50-75%) in many series involving thoracic traumas (11-13). However, these series are studies that include many etiologies, including falling causing blunt thoracic traumas and penetrating thoracic traumas. Tube thoracostomy is recommended under all circumstances in traumatic pneumothorax. Thus, life-threatening complications such as tension pneumothorax can be prevented [14]. Tube thoracostomy

TABLE V - *Surgical Experience Index - SEI*

	Junior Surgeon	Senior Surgeon	Points
General aspects			
Seniority on the field of surgery			
< 5 years	Yes	No	1 point
5-15 years	No	No	2 points
> 15 years	No	Yes	3 points
Nr. of surgical interventions performed annually			
< 200 operations	183	-	1 point
> 200 operations	-	343	2 points
Nr. surgeries performed annually in order to treat abdominal wall defects			
< 100 operations	73	-	1 point
> 100 operations	-	130	2 points
Minimal-invasive procedures			
Basic level operations			
Cholecystectomy	Yes	Yes	1 point
Appendectomy	Yes	Yes	
Intermediate level operations			
Treatment of inguinal hernia	Yes	Yes	2 points
Treatment of umbilical hernia	Yes	Yes	
Treatment of ventral hernia	Yes	Yes	
Treatment of hiatus hernia	Yes	Yes	
Advanced level operations			
Splenectomy	No	Yes	3 points
Treatment of colorectal cancer	No	Yes	
Specific aspects			
Nr. of elective inguinal hernia treatments annually			
< 50 interventions	-	-	1 point
> 50 interventions	52	79	2 points
Experience in laparoscopic inguinal hernia repair			
< 5 years	1	0	1 point
years	0	1	2 points
Average surgery duration (TAPP)			
Around 90 minutes	0	0	1 point
Around 60 minutes	1	0	2 points
Around 45 minutes	0	1	3 points
Postoperative complication rate after TAPP repair (%)			
Average	4.87%	5.35%	1 point
Length of hospital stay after TAPP repair (days)			
1-2 days	1	1	3 points
3-4 days	0	0	2 points
More than 4 days	0	0	1 point
Esthetic considerations after TAPP repair			
Use of simple surgical suture	0	1	1 point
Use of intradermic suture	1	0	2 points
Recurrence rate after TAPP repair (%)			
Without recurrence during study	1	1	3 points
One case of recurrence	0	0	2 points
More cases of recurrence	0	0	1 point
	20	**28**	**Score**

indications in hemothorax cases are more flexible according to the severity of the case and the findings. In this study, tube thoracostomy was performed for pneumothorax in 23 (16.9%) cases, hemothorax in 12 (8.8%) cases, and hemopneumothorax in 7 (5.1%) cases.

Indications for emergency thoracotomy in thoracic traumas, shock, ongoing bleeding symptoms and signs (bleeding 1500 ml or more in tube thoracostomy, 200 ml/hour bleeding in 2-4 hours, 100 ml in 6-8 hours /hour bleeding, the continuation of signs of hypovolemic

Table VI - *SEI and postoperative pain relationship.*

	Patients with pain Index > 18.5	Patients with pain Index < 18.5	P value	OR	RR
Early follow up					
SEI = 28	2 (3.57)	54 (96.43)	0.2473	0.325	0.518
SEI = 20	5 (10.20)	44 (89.80)	0.2473	3.068	1.929
Late follow up					
SEI = 28	2 (3.57)	54 (96.43)	1.0000	1.778	1.750
SEI = 20	1 (2.04)	48 (97.96)	1.0000	0.562	0.571

SEI = Surgical Experience Index.

shock despite blood replacement, completely opaque appearance of one side hemithorax on chest X-ray, hemopericardium or signs of cardiac tamponade, increasing or non-emptying hemothorax, trachea, bronchi, or diffuse parenchymal laceration, and continuing (>7 days) massive air leak despite tube thoracostomy [15]. In studies conducted in our country, thoracotomy rates are 1.2% to 12.7% [16]. In eccentric publications, the rates of thoracotomy are higher (10%-71) [17]. The low rate of thoracotomy in Turkey may be due to the difficulties in bringing the cases to the hospital due to transportation problems, and the inadequacy of physicians and equipment in health institutions. Thoracotomy was performed in 4 cases with penetrating gunshot wounds, and in 2 cases with hemothorax.

It is emphasized in the literature that central nervous system injuries are the most important system affecting mortality among these systems [18]. The fact that their heads are larger than the body is the reason why they are more affected by head traumas [19]. In the same way, extremity fractures and abdominal injuries may develop due to falling. In this study, it was found that thoracic trauma was accompanied by head trauma in 68 (15.7%), and head, and abdominal trauma in 48 (11.1%) of the cases. Developed by Tepas et al [20], "PTS" is a tool for rapid and accurate assessment of the traumatized child. It has six determinants. The total score ranges from +12 (no injury) to – 6 (fatal injury). As the score decreases, mortality increases. In cases with PTS above 8, mortality is zero. The lowest mean PTS in the spread trace was found in the group with thoracic trauma together with the head, extremity, and abdominal trauma (Table IV). The PTS of 3 patients who died in our study were – 1, +1, and +2. While mean PTS in cases with isolated thoracic trauma was determined as 7, a statistically significant (p=0.002) decrease in PTS value was detected in the presence of additional system injuries (Table IV).

In the literature, it is emphasized that HCS is prolonged by 3 to 4 times in the presence of a blunt head, blunt abdomen, and orthopedic injuries accompanying falls [21]. In our series, while HCS was on average 4.5 days in isolated thoracic trauma cases, a statistically significant (p=0.001) increase was observed in additional other system injuries in this period.

Conclusion

Chest wall, pulmonary, mediastinal, and diaphragmatic structures can be damaged in chest trauma. However, it should be kept in mind that every chest trauma patient may also have polytrauma, and accompanying injuries should be carefully examined. Thorax and accompanying injuries after trauma is seen most frequently in the summer months. The fact that children did not go to school and preferred to play outside during this period may explain the increase in such accidents. Protective measures reduce injuries. Providing training on prevention from accidents in schools and other places (environments), especially for children and parents, and the construction of playgrounds and sports fields with solid infrastructure will reduce the rates of accidents and injuries.

Riassunto

La finalità di questo studio è di analizzare retrospettivamente le caratteristiche dei traumo toracici nei bambini ricoverati nella nostra clinica tra febbraio 2011 e gennaio 2022.

Risultati: Il 31,5% (n=136) dei 432 casi presentava un trauma toracico isolato. L'età media era di 8,7±4 anni, il 74,3% erano maschi (n=321) e il 25,7% femmine (n=111). Le concomitanti ferite contusive erano presenti nell'84%, le ferite da coltellate penetranti erano del 12% e le ferite da arma da fuoco erano del 4%, mentre il tasso di traumi penetranti di età superiore ai 15 anni era del 24,8%. Le cause più comuni sono state gli incidenti stradali (42,4%) e le cadute dall'alto (23,9%). Le patologie più comuni di complicazione erano: contusione polmonare (71,7%), pneumotorace (48,7%), frattura costale (18%) e lacerazione polmonare (12%). La toracostomia con tubo è stata eseguita in 51 (46,4%) dei 110 casi con pneumotorace. La toracostomia è stata eseguita in 2 casi di ferite da arma da fuoco penetranti e la toracostomia del tubo è stata eseguita in 2 casi con emotorace. La degenza media in ospedale è stata di 7 giorni e 1 caso con grave trauma cranico è deceduto.

CONCLUSIONE: Le strutture della parete toracica, polmonare, mediastinica e diaframmatica possono essere danneggiate in caso di trauma toracico. Tuttavia, va tenuto presente che ogni paziente con trauma toracico può anche avere un politrauma e le lesioni che lo accompagnano devono essere esaminate attentamente.

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