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Thoracolumbar Fractures in Adolescent Patients: Epidemiological, Clinical, Radiological Characteristics and Recent Methods of Management

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ABSTRACT

Background: Spine fractures account for a large portion of musculoskeletal injuries worldwide; approximately 54.9% of the patients had fractures in the thoracolumbar spine; with most of these occurring at the thoracolumbar junction (T10-L2)**.**

Objective: To assess the epidemiologic characteristics of spinal injuries in adolescents, their unique anatomic, and radiographic characteristics.

Patients and Methods*:* 18 selected patients presented with traumatic thoracolumbar fractures admitted to the Neurotrauma Unit of Neurosurgery Department, Zagazig University Hospitals, and Al-Ahrar Teaching Hospital, Sharkia, Egypt with our study prospective study and post-resuscitation they were of both sexes and their age range starts from 12:17 years adolescent group.

Results: the number of patients (18 patients) was 20.2% from 189 cases of all spine fractures in adolescent patients. Sex were 11 males (61.1%) falling from height is the most common cause of thoracolumbar fractures (50%), followed by road traffic accidents (33.3%). the most common type of fracture in both groups was a wedge and burst where it constituted more than 80%. Orthopedics fractures were the most common associated injuries which were found in 6 patients (33%). According to motor power, 14 patients had full motor power (77.7%). the most common level of injury was L1 vertebrae 11patients (61.1%). The mean height of the vertebral body in the conservative treated group was 26.11±4.85**,** but in the surgically treated group is 25.55 ±4.63.

Conclusion: The most common cause of trauma was fall from a height (50%)**.** The most affected vertebra was L1 (61.1%)**.** Over 80% of patients were neurologically intact**.** The angle of kyphosis in the surgically treated group improved and decreased from 23 degrees to18.22 degrees.

Keywords: Serum Eosinophil Derived Neurotoxin, Bronchial Asthma, Evaluation, Severity.

INTRODUCTION

Spine fractures account for a large portion of musculoskeletal injuries worldwide; approximately 54.9% of the patients had fractures in the thoracolumbar spine [(1)]; with most of these occurring at the thoracolumbar junction (T10-L2)[(2)]**.**

In other literature, the incidence of thoracolumbar injuries in children and adolescents is quite variable and ranges between 5.4 and 34%[(3)]**.**

The Thoracolumbar Junction (TLJ) (T10-L2) represents a transitional zone with a straight spinal segment between the long stiff kyphotic thoracic spine and the mobile lordotic lumbar spine, and transition of facet orientation from the coronal facet joints of the thoracic spine to the sagittal facet joints of the proximal lumbar spine [(4, 5)]**.** Adolescence is a transitional stage of physical and psychological development that generally occurs during the period from puberty to legal adulthood (age of majority) mostly from12-17 [(6)]**.**

Injuries of the spine are rare in young children but increase significantly in adolescents from 12 to17 years of age [(7)]**.**

The study aimed: To assess the epidemiologic characteristics of spinal injuries in adolescents, their unique anatomic, and radiographic characteristics. To evaluate the mechanisms of injury and the clinical and radiographic evaluation of these injuries regarding the principles of non-operative and operative management of injuries to the adolescent thoracolumbar fractures.

PATIENTS AND METHODS

Patients:

Between April 2018 and April 2019, 18 selected patients presented with traumatic thoracolumbar fractures admitted to Neurotrauma Unit of Neurosurgery Department, Zagazig university hospitals and Al-Ahrar Teaching Hospital, Sharkia, Egypt with our study prospective study and post-resuscitation they were of both sexes and their age range starts from 12:17 years adolescent group. All patients were admitted after first aid measures.

Inclusion criteria:

(1) All thoracolumbar fractures coming to the ER including different types and grades according to AO spine classification of thoracolumbar fractures.
(2) Age: 12-17 years.
(3) Sex: Both sexes are included.

Exclusion criteria:

- Age above 18 years.
- Completely healed fractures (no edema on MRI or normal bone scan).
- Active infections: sepsis, osteomyelitis, discitis, and epidural abscess.

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Methods:

All cases were submitted to careful history taking, general and neurological examinations, and routine laboratory investigations. All cases had first aid management line, and then subjected to imaging investigations in the form of ***plain X-ray*** thoracolumbar spine; anteroposterior and lateral views ***computed tomography*** and ***magnetic resonance imaging*** of the thoracolumbar spine.

The following sheet was applied for the studied cases as follow:

(A) History taking:

- **Personal history:**
  - Name. Age. Sex. Occupation.
- **History of present illness:**
  - Time of trauma. Type of trauma. Neurologic deficit after trauma:
    - Motor weakness (in one or both lower extremities).
    - Sensory impairment (hypothesia, anesthesia, dysesthesia, or paresthesia).
    - Sphincteric troubles (incontinence or retention).

(B) Examination:

- **General examination:**
  - To detect any associated injury as head injury, chest injury, bone injury, or visceral injury.
  - To assess vital signs and fitness of the patient for surgery.
- **Local examination:**

The back was examined for tender spine or paravertebral muscles, angulation deformity, and limited movements and abrasions or contusions.

- **Neurological examination:**

To evaluate the neurological status of the patient with regards to thoracolumbar injury classification and severity (TLICS) scale. The neurological functional level of the patient can be assessed preoperatively, postoperatively by the ASIA impairment scale.

Thoracolumbar injury classification and severity (TLICS) scale *(2).*

- **Radiological (imaging) investigations:**

(A) *Plain X-ray spine:*

Anteroposterior (AP) and lateral views were performed at the site of skeletal injury in all cases.

- ***A-P view*** for assessment of:
  - Vertebral body height.
  - Asymmetry of the body.
  - Asymmetry of pedicles.
  - Interpedicular distance.
  - Alignment of spinous processes.
  - Integrity of laminae and pars interarticularis.
  - Continuity of facet joints.
  - Transverse process or rib fracture.
- ***Lateral view*** for assessment of:
  - Disc space height.
  - Continuity of facet joints.
  - Interspinous distance.
  - Vertebral body height.
  - Continuity of lamina-pedicle and pedicle body junction.
  - Maintenance of sagittal curves.
  - Normal angulation of adjacent bodies.

Analysis of X-ray:

Multiple parameters were selected for comparison between the preoperative, immediate postoperative, and 6-month follow-up lateral X-ray films.

Local kyphotic angle (Cobb's angle) is formed between a line drawn parallel to the superior endplate of the vertebral bone fractured and a line drawn parallel to the inferior endplate of the vertebral bone fractured ***or*** the angle between 2 lines; the first is perpendicular to a line drawn parallel to the superior endplate of one vertebra above the fracture and the second is perpendicular to a line drawn parallel to the inferior endplate of one vertebra below level the fracture [(8)].

(B) *Computerized Tomography (CT):*

Preoperative CT scan (axial cuts) was done for all cases to determine the extent of canal compromise, delineate the fracture anatomy, and also detect the type of thoracolumbar injury based on a three-column Denis theory of spinal stability.

Three-column Denis theory of spinal stability:

(1) Compression fractures: Compression failure of the anterior column.

(2) Burst fractures: Compression failure of anterior and middle columns.

(3) Seat belt injuries: Distraction failure of the posterior and middle columns.

(4) Fracture dislocations: Failure of all columns[(9)].

CT also helps in the assessment of the pedicles of the fractured vertebra along with the cephalic and the caudal ones for surgical planning as the pedicles are the structure of the posterior elements that harbor the pedicular screws [(10)].

It can also detect the degree of canal occlusion through determining the cross-sectional area which is expressed as a percentage of normal. If the canal occlusion is between 0-25% (the cross-sectional area is between 75-100%), this is considered class A, class B if the occlusion is between 25-50% while class C,

if the occlusion is between 50-75%, more than 75% occlusion is considered class D [11].

(C) ***Magnetic Resonance Imaging (MRI):***

It was done for all patients to evaluate: etiology and pathology of the neural injury and also used to evaluate soft tissue injuries, including the spinal cord, nerve roots, and ligamentous injury and also to reveal mass intrusions into the spinal canal as traumatic disc herniations, bony protrusions, and hematoma [12].

Ethical approval and written informed consent:

An approval of the study was obtained from Zagazig University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

Statistical Analysis

Data collected throughout history, basic clinical examination, laboratory investigations, and outcome measures coded, entered, and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) **(**Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, a quantitative continuous group represented by mean ± SD, the following tests were used to test differences for significance, difference, and association of qualitative variable by Chi-square test (X^2). Differences between quantitative independent groups by t-test or Mann Whitney. P-value was set at <0.05 for significant results & <0.001 for high significant result.

RESULTS

In this study, it was found that males were more commonly affected than females (3:2) **(Table 1).**

Fall from height was the most common cause of thoracolumbar fractures (50%), followed by road traffic accidents (33.3%) **(Table 2).**

The most common type of fracture in both groups was wedge followed by burst where they constituted more than 80% **(Table 3).**

All most 88% of our cases were neurologically intact (motor83.8% _sensory88.8% _sphincter 83.3%) **(Table 4).**

L1 vertebrae was the most common level of injury (11 patients) followed by D12 (4patients). Canal compromise was present in 55.5% of patients **(Table 5).**

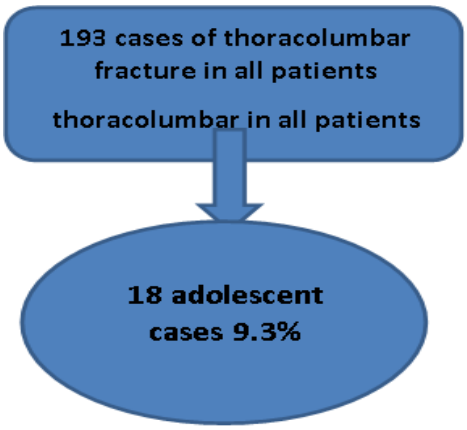

Figure (1): Demographic data of our patients.

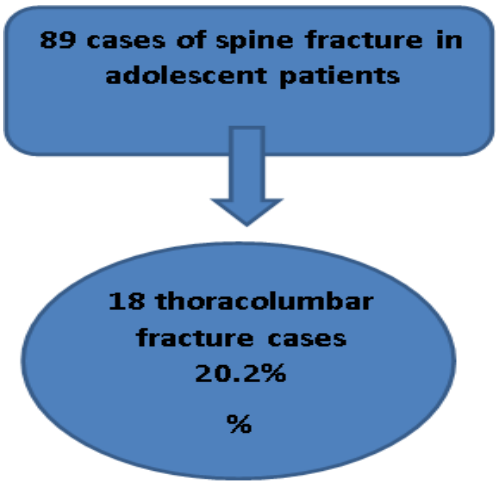

Figure (2): Thoracolumbar fractures cases.

Table (1): Sex distribution among the studied group (N=18).

		Frequency	Percent
Sex	**Female**	**7**	**38.9**
	Male	**11**	**61.1**
	Total	**18**	**100.0**

Table (2): Mode of trauma in the studied patients**.**

		N	%
Mode of trauma	**Fall from height**	**9**	**50.0**
	Fall heavy object on the back	**1**	**5.6**
	Road traffic accident	**6**	**33.3**
	Sport	**1**	**5.6**
	Stairs	**1**	**5.6**

Table (3): Type of fracture in the studied patients.

		N	%
Type of fracture	**Burst**	**7**	**38.9**
	Burst + spine process	**1**	**5.6**
	Spine process	**1**	**5.6**
	Transverse process	**1**	**5.6**
	Wedge	**8**	**44.4**

Table (4): Pre-treatment clinical & functional assessment.

Pre-treatment clinical & functional assessment	**Thoracolumbar fractures patients (N=18)**	
	No.	**%**
Sensory(superficial-deep)		
• **Normal**	**15**	**88.8%**
• **Sensory level**	**2**	**12.5%**
• **Hypothesia**	**1**	**5.5%**
Motor		
• **G0**	**2**	**12.5%**
• **G1**	**1**	**5.5%**
• **G2**	**1**	**5.5%**
• **G3**	**0**	**0%**
• **G4**	**0**	**0%**
• **G5**	**14**	**77.7%**
Sphincter		
• **Intact**	**15**	**83.3 %**
• **Retention**	**3**	**16.7%**
AISA		
• **A COMPLETE**	**2**	**11.1**
• **B**	**0**	**0**
• **C**	**2**	**11.1**
• **D**	**0**	**0**
• **E Normal**	**14**	**77.8**
• **Total**	**18**	**100**
VAS		
• **Mean ± SD**	**7.08±1.36**	
• **Median (Range)**	**7.0 (4.4-9)**	

Table (5): Pre-treatment imaging assessment.

Pre-treatment imaging assessment	Thoracolumbar fractures patients (N=18)	
	No.	%
Level of fracture		
• **D11**	**1**	**5.6%**
• **D12**	**4**	**22.2%**
• **L1**	**11**	**61.1%**
• **L2**	**2**	**11.1%**
Vertebral height		
• **Mean ± SD**	**25.83 ± 4.61**	
• **Median (Range)**	**27.5 (20 – 30)**	
Kyphotic angle		
• **Mean ± SD**	**23.22 ± 8.61**	
• **Median (Range)**	**25.0 (5 – 35)**	
Canal compromise		
• **Negative**	**8**	**44.4%**
• **Positive**	**10**	**55.5%**
Neural compression		
• **Negative**	**8**	**44.4%**
• **Positive**	**10**	**55.5%**

DISCUSSION

The number of patients in our study (18 patients) was less than **Parisini *et al.*** [13] who collected 44 patients in their study and **Defino and Canto** [14] who collected 20 patients in their study and we were similar to study of **Defino and Scarparo** [15] who collected 18 patients in their study.

To our knowledge, this study is the first study of epidemiological, clinical, radiological characteristics, and recent methods of management of traumatic thoracolumbar fractures in adolescents in Egypt.

In the present study, the number of patients (18 patients) was 20.2% from 189 cases of all spine fracture in adolescent patients .we were similar to the study of **Osenbach and Menezes** [16] and **Carreon *et al.*** [3] which range from 17% to 21%.In contrast, the author of other studies (**17)** had reported higher frequencies of thoracolumbar spinal injuries constituted 52.9% of all pediatric spinal trauma cases.

The incidence of thoracic and lumbar injuries in children and adolescents is quite variable and ranges between 5.4 and 34% according to the study of **Carreon *et al.*** [3] **and Cirak *et al.*** [18]**.** In our study, the number of thoracolumbar fractures in adolescents was 9.3% of all patients of thoracolumbar fractures (193 patients) during one year.

The demography of our patients regarding sex were 11 males (61.1%) and 7 females (38.9%). That had no statistically significant compared with the study of **Wang *et al.*** [19]. We were similar to the study of **Dogan *et al.*** [17] who collected 89 patients (46 boys and 43 girls) and **Courvoisier *et al.*** [20] who collected 198 patients (102 boys and 96 girls)**.**

Regarding the cause of the trauma, we noticed that falling from height is the most common cause of thoracolumbar fractures (50%), followed by road traffic accidents (33.3%).

Avanzi *et al.* [21] performed their study in Sao Paulo in Brazil and had 73% of cases caused by falling from height and 27% caused by road traffic accidents, and in the study reported by **Yan *et al.*** [22]**,** the incidence of falling from height was 63.5% and 25% by road traffic accidents. In the study of **Liu *et al.*** [23] which included 82 720 patients with spinal trauma, most injuries occur during recreational or sports activities (53%), followed by motor vehicle accidents (26%). Falls from a height are the mechanism of injury in 13% of thoracolumbar fractures of childhood. In the study of **Dogan *et al.*** [17]; Motor vehicle accidents (57.3%) were the most common cause of injury which was different from our study. Falling from a height in this study may be explained by the suicidal attack (4 patients), bad housing, low socioeconomic standard, unsafe measurements in different houses and sports-related activities are low as we have no high sports activity in our local community due to low socioeconomic standard also the available sports activity isn't associated with high energy enough to cause such fractures. High way road is relatively away from our hospital and cases with fracture spine due to motor vehicle accidents may not reach us because of severe associated injuries from which patients may die before arrival to our hospital.

Wedge fractures are the most common injury pattern observed in the pediatric thoracic spine because of the wedge shape of the immature vertebral

body and the presence of a natural kyphosis. Axial loading, such as that experienced in football injuries, diving, or falls, may result in compression injuries. Hyperflexion injuries are more common than hyperextension injuries or dislocation injuries and result in compression failure of the anterior column [(7)]**.** In our study, the most common type of fracture in both groups was a wedge and burst where it constituted more than 80% compared to the study of **Santiago *et al.*** [(24)] wedge fracture (75%). Other study of **Savage *et al.*** [(25)] found that wedge fracture 5patients (25%) and burst fracture 6 patients (30%) from 20 patients**.** In the pediatric spine, burst fractures occur in patterns similar to those seen in adults in that they usually occur at the thoracolumbar junction and can include the annular epiphysis and the intervertebral disc. Burst fractures in younger children can also damage the germinative layer, however, which may lead to premature epiphyseal fusion. As in adults, some thoracolumbar burst fractures that are accompanied by an intact posterior osteoligamentous complex can behave as mechanically stable injuries [(26)].

Patients with multiple injuries present diagnostic and therapeutic problems [(27)]. Spinal trauma frequently is associated with concomitant systemic injuries, including head, intra-abdominal and thoracic injuries, and long bone fractures [(23)]**.**

In this study, Orthopaedics fractures were the most common associated injuries which were found in 6 patients (33%) followed by cranial injuries 3 patients (16.8%), Abdominal and cardiothoracic injuries are presented in 2 patients (11.2%) Comparable to **Dogan *et al.*** [(17)] those reported that head injury was the most common injury associated with spinal trauma.

In our study almost 88% of our cases were neurologically intact (motor 83.8%, sensory 88.8%, sphincter 83.3%%).we were almost similar to the study of **Dogan *et al.*** [(17)] (89.9%) were neurologically intact when compared with the study of **Rajasekaran *et al.*** [(28)] (78%) neurologically intact.

According to motor power, 14patients had full motor power (77.7%), 1 patient had motor power grade 2 (5.5%), 1 patient had motor power grade 1 (5.5%) compared with study of **Hitchon *et al.*** [(29)] (83) patients had full motor power from 255 patients. According to sphincteric condition 15 patients were sphincteric intact (83.2%) 3 patients had retention (16.6%) comparable with study of **Heary and Iqbal** [(30)] (8 0%) had intact sphincter and (20%) retention. The elasticity of the pediatric spinal column far exceeds that of the spinal cord and dura **(31).** Because of the elasticity and compressibility of bone in children, pediatric spine trauma is less likely to result in direct bony injury. Recognition of spinal trauma in this population can be challenging with routine emergency radiography **(13)**. As a consequence of these unique features, the anatomy, patterns of injury, and management of pediatric thoracolumbar spine trauma warrant special consideration [(32)].

Regarding VAS, its mean range 7.08±1.36and median range 7.0 (4.4-9).comparable with the study of **Hitchon *et al.*** [(29)] (VAS 1.9 ±1.9).

In our study, the most common level of injury was L1 vertebrae 11patients (61.1%) followed by T12 vertebrae 4 patients (22.2%) then L2 vertebrae 2 patients (11.2%) and finally D11 was the same 1 patients (5.6%). **Dogan *et al.*** [(17)] had a predominance of L_1 (76% of the cases), followed by L_2 (16%) and lastly D_{12} in 12% of cases, also **Yan *et al.*** [(22)] revealed that L_1 was the most common affected vertebra, representing 37.5% of cases and with the study reported by **Danisa *et al.*** [(33)] reported predominance of L_1 fracture; in all studies, we noted that L_1 vertebra is the most commonly affected and that could be due to that L_1 is located at the center of the transition zone between stiff kyphotic dorsal and mobile lordotic lumbar spine and between the coronal orientation of thoracic spine facets and sagittal lumbar facet orientation. So, these conditions put L_1 under maximum stress and make it more liable to fracture.

In our study, the mean height of vertebral body in the conservative treated group was 26.11±4.85**,** but in the surgically treated group was 25.55 ±4.63 compared to the study of **Sadiqi *et al.*** [(34)] vertebral body height in the conservative group was mean32.55±6.8 and in the surgical group is 30.11±6.55.

Canal compromise was present in 10 patients (55%) with mean 15.88±8.89 in the conservative treated group and (41.11±17.69) in the surgically treated group lower levels of thoracolumbar junction than upper levels. Which is statistically significant in the surgical group and comparable to the study of **Hitchon *et al.*** [(29)] (52% ±14%)

Measurements of kyphosis were made in using the cobb method, after producing lateral view radiographs of the segment affected [(8)]**.**

In our study angle of kyphosis was 17.22 ± 8 less than the study of **Hitchon *et al.*** [(29)] angle of kyphosis was (8±10).

The mean range of VAS was (3.25) compared to the study of **Hitchon *et al.*** [(29)] 255 patients with thoracolumbar burst fractures were treated by their department. There were 172 patients with neurological deficits, all of whom were treated with decompression and instrumentation. The remaining 83 were neurologically intact and were given a trial of no operative treatment with gradual mobilization.

CONCLUSION

This study conducted 18 adolescent patients with thoracolumbar fractures during a year.

- The most common cause of trauma was fall from a height (50%)
- The most affected vertebra was L1 (61.1%)
- Over 80% of patients were neurologically intact
- Fifty percent of patients were treated conservatively
- Fifty percent of patients were treated surgically
- The angle of kyphosis in the surgically treated group improved and decreased from 23 degrees to 18.22 degree

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