

## Pediatric Thoracic and Lumbar Spinal Fractures

### Pediatric Torakal ve Lomber omurga kırıkları

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#### ABSTRACT

**Aim:** Vertebral body fractures in childhood are rarely observed and differ from those in adults due to incomplete ossification. There is no guideline for the management of pediatric thoracolumbar spinal fractures. The aim of this study is to examine the epidemiological data of our pediatric patients treated for thoracic and lumbar vertebral fractures and to contribute to the decision-making processes regarding the diagnosis and treatment of these patients.

**Methods:** Patients under 16 years of age who were admitted to the emergency department of Alanya Education and Research Hospital with a history of spinal trauma and diagnosed with thoracic and lumbar vertebral fractures between 2016-2023 were included. Our study included patients whose demographic data, causes of trauma, diagnostic tests, and treatments were accessed using the hospital's clinical database.

**Results:** Among 154 patients admitted to our hospital with a diagnosis of spinal trauma, 21 patients who met the inclusion criteria were included in the study. Thirteen patients had a single vertebral body fracture, five had fractures in two vertebral bodies, and three had pars fractures leading to traumatic spondylolisthesis. Four patients underwent surgery due to vertebral fractures.

**Conclusion:** The pediatric spine's biomechanical structure and self-healing ability differ from adults. Pediatric spinal traumas are important pathologies that need to be studied due to their rarity, difficulty in diagnosis, lack of experience in treatment, and potential complications that may develop in the long term.

Key words: Lumbar, Thoracic, Spine, Trauma, Pediatric

#### ÖZ

**Amaç:** Çocukluk döneminde vertebra korpus kırıkları kemikleşme tam olmadığı için yetişkinden farklılıklar gösterir ve oldukça nadir görülür. Pediatrik torakolomber spinal fraktürlerin yönetimi hakkında bir klavuz yoktur. Bu çalışmanın amacı torakal ve lomber vertebra kırığı nedeniyle tedavi ettiğimiz pediatrik hastalarımızın epidemiyolojik verilerini incelemek ve bu hastaların tanı ve tedavisine ilişkin karar alma süreçlerine katkıda bulunmaktır.

**Yöntem:** Alanya Eğitim Araştırma Hastanesi acil servisine 2016-2023 yılları arasında spinal travma hikayesi ile gelen torakal ve lomber vertebra kırığı tanısı alan 16 yaş altındaki hastalar dahil edilmiştir. Çalışmamıza, hastanemiz klinik veri tabanı kullanılarak, demografik verilerine, travma nedenlerine, tanılarda kullanılan testlerine ve tedavilerine ulaşılan hastalar dahil edilmiştir.

**Bulgular:** Hastanemize omurga travması tanısı ile yatırılan 154 hasta arasından dahil edilme kriterlerini karşılayan 21 hasta çalışmaya dahil edilmiştir. Hastaların 13 tanesinde tek vertebra korpus kırığı, 5 tanesinde 2 vertebra korpusunda kırığı, 3 tanesinde travmatik spondilolistezise yol açan pars kırığı vardı. Hastaların 4 tanesine vertebra kırığı nedeniyle operasyon uygulandı.

**Sonuç:** Pediatrik omurganın biomekanik yapısı ve kendini iyileştirme yeteneği yetişkinden farklıdır. Pediatrik spinal travmalar nadir görülmesi, tanısının zor konulması, tedavisi konusundaki tecrübenin azlığı ve uzun dönemde gelişebilecek komplikasyonlar nedeniyle üzerinde çalışılması gereken önemli patolojilerdir.

Anahtar kelimeler: Lomber, Torakal, Omurga, Travma, Pediatrik

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## Introduction

The spine shows different biomechanical and structural characteristics in different age groups as it changes throughout life. The approach to spinal trauma varies in parallel with the development of the spine. Spinal traumas occurring in the pediatric period account for 1-4% of all spinal traumas. Although spinal traumas are more commonly observed in the cervical region due to the head-to-body ratio in the first years of life, they are observed in the thoracic and lumbar vertebrae at older ages. In adults, vertebral fractures are primarily caused by high-energy trauma, whereas in children, they are typically observed following low-energy trauma, such as falls and sports injuries [1,2,3]. 20-40% of pediatric spinal traumas are observed in the thoracic and lumbar regions. Pediatric thoracic and lumbar fractures account for less than 1% of all spinal traumas. Although it has been reported to be more commonly observed in male children between the ages of 13 and 16, it exhibits different epidemiological characteristics across different populations [1-5].

The pediatric spine differs from the adult spine in several aspects.

In the thoracolumbar region of the pediatric spine, there are three ossification centers: one in the center and two in the neural arches. Ossification of the vertebral body begins at the 10th week of gestational life, with less than 70% ossified at birth. This process accelerates between the ages of 2 and 6 and is typically complete by around the age of 10 [6, 7]. The facet joints of pediatric vertebrae are horizontally oriented before the age of 8, allowing for greater mobility, but they become more inclined during childhood and resemble the adult structure by the age of 15. The ligaments and connective tissues that provide spinal stability are more lax compared to adults, allowing for greater movement. Consequently, due to the increased mobility and elasticity of the pediatric thoracolumbar vertebrae in early life, fractures in this region are relatively rare [2,7,8,].

As vertebral fractures developed during the pediatric period can lead to various neurological problems and spinal deformities in the long term due to the growing skeleton, patients need to

be followed up in the long term. In this study, we aimed to discuss the epidemiological data, treatment approaches, and prognosis of our pediatric patients treated for thoracic and lumbar vertebral fractures, whose treatment decision-making processes differ from those of adult patients, in the light of the literature.

## Methods

Patients under the age of 16 with a history of spinal trauma who were diagnosed with thoracic and lumbar fractures and presented to the emergency department of Alanya Education and Research Hospital between 2016 and 2023 were included in the study. Patients whose demographic data, causes of trauma, diagnostic tests and treatments were accessed in the clinical database of our hospital were included in the study. Patients with vertebral body fractures were evaluated according to the AO-Spine Magerl Thoracolumbar Injury Classification system, while patients with spondylolisthesis were assessed using the Meyerding classification. Patients with incomplete epidemiological data, as well as those whose diagnostic tests and treatment methods were unavailable, were excluded from the study.

## Statistical analysis

We used SPSS version: 23 to evaluate the data of our study. The data obtained from our patients were analyzed with frequency and percentage distributions from descriptive statistical methods.

## Results

21 patients who met the inclusion criteria among 154 patients hospitalized in our hospital with the diagnosis of spinal trauma were included in the study. Ten (48%) of the patients were female and 11 (52%) were male. The mean age at the time of injury was 10.4 years (5-16). Seven of the patients were fall from height, 8 were pedestrian injuries, 2 were in-vehicle traffic accidents and 4 were sports or game injuries. All patients had multiple trauma. Seventeen (81%) of the patients were treated conservatively and 4 (19%) were treated surgically. The diagnosis of all patients was made by tomography. Spinal MRI was performed in a total of 11 patients, 3 of whom were sedated to investigate the presence of additional spinal

Table1: Patient list

N	M/F	Age	Vertebra	Trauma	Treatment	Hospit.	AO Magerl Cl.
1	F	7	L5 Pars F	Spor	Conservative	9	1.°Listhesis
2	M	10	T7, T8	Fall H.	Conservative	8	A1-A3
3	F	12	T12	Fall H.	Surgery	15	A4
4	M	9	L2	Out-TA	Conservative	11	A2
5	F	11	T6, T7	İn-TA	Conservative	16	A1-A3
6	M	9	L1	Spor	Conservative	6	A3
7	F	5	T7, L2	İn-TA	Conservative	5	A1-A4
8	M	14	L2	Out-TA	Surgery	18	A4
9	M	15	T10	Fall H.	Conservative	7	A1
10	F	9	L3	Spor	Conservative	3	A3
11	F	16	L3	Out- TA	Conservative	6	A3
12	M	10	L4 Pars F	Fall H.	Conservative	4	1.°Listhesis
13	F	14	L2, L3	Fall H.	Surgery	35	C-C
14	M	7	T12	Out-TA	Conservative	7	A1
15	M	13	L1	Out-TA	Surgery	14	A4
16	F	9	L2	Spor	Conservative	4	A2
17	M	8	T7	Fall H.	Conservative	6	A1
18	M	10	L5 Pars F	Out-TA	Conservative	2	1.°Listhesis
19	F	8	T6	Out-TA	Conservative	17	A2
20	M	11	L3, L4	Fall H.	Conservative	13	A3-A1
21	F	13	L2	Out-TA	Conservative	5	A3

M:Male, F: Female, Fall H.:Fall From Height, İn-TA: In-Car Traffic Accident, Outs-TA: Outside Vehicle Traffic Accident, AO Magerl Cl: AO-Spine Magerl Thoracolumbar İnjury Classification System, Hospit: Hospitalization, Pars F: pars fracture.

pathology. Three of the patients (14.2%) had a pars fracture leading to traumatic spondylolisthesis. Five of the patients had fractures in 2 vertebral body. Among these patients, a single patient had fracture in the thoracic region, two patients had in the lumbar region and two patients had in both thoracic and lumbar regions. Within the group of patients with one vertebral body fracture, 5 were in the thoracic and 8 in the lumbar region. According to the AO-Spine classification, the most common types of vertebral body fractures observed were wedge compression (31%) (Type A1) and incomplete burst (31%) (Type A3). Older children and adolescents had higher grade injuries based on the AO-spine classification. The most commonly affected vertebra was L2 (n=6, 28.5%). Permanent neurological deficit developed in very few patients without mortality (n=2, 9.5%). The mean length of hospital stay was 10.04 (2-35) days and, followed up duration for patients was 6.7 months (3-64 months).



Figure 1. T7 and L2 vertebra fracture of a 5 year old girl injured due to in-car traffic accident

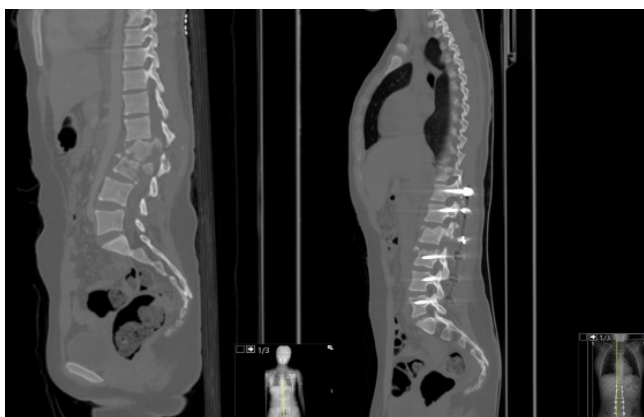


Figure 2. L2 and L3 vertebra fractures of a 14-year-old girl injured as a result of falling from a height and postoperative

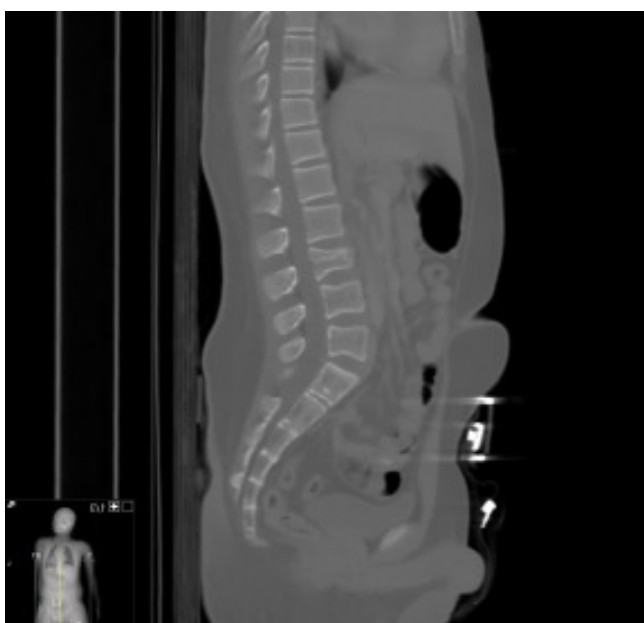


Figure 3. L3 vertebra fracture of 9 year old boy injured due to a fall during sports

## Discussion

1-3% of all paediatric fracture cases are in the spinal region. The incidence of pediatric spinal fractures increases during the first five years of life and again after the age of 10 [9]. Compared to adults, the pediatric spine exhibits greater elasticity due to incomplete ossification, underdevelopment of paraspinal muscles, anatomical position of facet joints, and changes in the amount of collagen and water in the nucleus pulposus. After the age of eight, the differences gradually diminish. After 15 years of age, it shows fracture characteristics similar to adults [2,8]. As the head-to-body ratio is larger in children younger than 8 years old, cervical traumas are more frequently encountered

in early childhood. Multiple vertebral fractures are observed more frequently since the body of the vertebrae are wedge-shaped and smaller in adults to carry high forces [10,11]. Spinal cord injuries without fracture are also observed in this age group because of vertebral flexibility. Saul et al. reported that 9% of paediatric vertebral fractures occurred in the cervical region, 56% in the thoracic region and 31% in the lumbar region [4]. Mendoza et al. reported that 40.9% of paediatric traumas occurred in the lumbosacral region, 32.9% in the cervical region and 26.2% in the thoracic region [10].

In the thoracolumbar region, collapse fractures of the vertebral body are observed most frequently in children as in adults. Unlike adults, L2 vertebral fracture is observed most frequently in the thoracic and lumbar region in childhood [1,2,12]. Similar to these findings, we also observed L2 vertebra fractures as the most frequent occurrence in our study.

Herren et al. reported that although the thoracolumbar region is more commonly affected in childhood, middle thoracic vertebrae are more frequently injured in older children and adolescents. Vertebral fractures are frequently observed as compression fractures in the thoracic region and burst fractures in the lumbar region [2]. We could not make such a distinction in our study.

Although in various studies, different results have been reported, it is observed that the ratio is equal in larger series [1,2,4]. In our study, a higher number of male patients were found.

Vertebral body fractures in the sagittal plane are more frequently observed than those in the coronal plane. Ligament injuries, epiphyseal detachments or fractures of the ossification centres are observed more frequently in paediatric cases compared to adults due to the high elasticity. In children less than 8 years old, dislocation or spondylolisthesis without fracture is observed more frequently [2,11]. In our study, we observed grade 1 spondylolisthesis due to 3 pars fractures. The mean of our patients' age was below the overall mean.

Multiple vertebral fractures are observed more frequently because the body of the vertebrae are

wedge-shaped and smaller in adults to carry high forces. Multiple vertebral injuries in the paediatric spine were found to be 32% [13]. Herren et al. found an additional injury in another spinal segment in maximum 1.2% of patients [2]. In our study, 2 vertebral segments were involved with a rate of 23%. It is thought that vertebral fractures are overlooked in paediatric patients because the whole spine is not scanned to avoid radiation exposure. In a series evaluating paediatric vertebral fractures, 6% were found to be 3 levels away from the primary injury. MRI has been recommended to show lesions that may be missed on CT such as epidural haematoma, discoligamentous injuries, traumatic disc herniation and low-grade vertebral fractures. However, it is difficult to perform MRI without sedation in childhood because of the acquisition conditions [13].

Surgical treatment is less commonly used in children due to their high healing and remodelling capacity. Conservative treatment is recommended for wedge-shaped compression fractures without neurological deficit. In order to prevent kyphosis, the use of orthoses that maintain the spine in extension is often sufficient for the treatment of the patient [14]. Surgical treatment is considered appropriate in cases when kyphosis exceeds 30 degrees. In pediatric cases with burst fracture in paediatric cases as in adults, treatment plan is made according to neurological deficit and stability of the fracture. The most common vertebral fractures requiring surgery in the paediatric period are in the lumbar region [4,15]. Surgical treatment is performed in 7.5-30% of patients with paediatric thoracolumbar spinal trauma [5,16]. In our study, surgical procedures were required in 19% of patients.

Spinal injuries overlooked during childhood may result in impaired spinal range of motion and deformities in later adulthood. Early surgical decompression and stabilisation in patients with spinal cord injury have a positive affect clinical outcomes [17]. It has been reported that 90% of patients who develop cord injury due to spinal trauma in childhood may develop spinal deformities in the following years. Instability has been reported to develop in cases in which decompression was performed without stabilisation [6,15]. Decrease in vertebral body height by more than 40%, kyphosis

of 15°-30°, 35-50% spinal canal compression, translation by more than 2.5 mm and involvement of the posterior tension band are considered as signs of instability in the thoracolumbar region [3,18].

Gavira et al. conducted a study to differentiate between conservative and surgical treatment in paediatric thoracolumbar vertebral fracture patients. A road map was prepared by determining physiological bone age according to the Risser classification and fracture type according to the Magerl classification. A conservative treatment for patients with bone age Risser 1 and fracture type A1-A2-A3-B was recommended. In addition to this, It is recommended to determine the treatment method applied to the the Risser 2-4 patient groups according to kyphosis and canal compression. Moreover, in the Risser 5 patient group, it has been found that applying the same treatment protocol as in adults is indicated [3]. In our study, surgery was performed in 4 patients, 3 of whom had A4 and 1 had C group fractures. Open decompression and instrumentation were performed as the surgical procedure. Similarly, in a study conducted on 153 patients in Germany, 1/3 of the patients needed surgery. In this study, it was suggested that the application of minimally invasive percutaneous screw placement technique in paediatric cases requiring thoracolumbar surgery without fusion is an appropriate treatment method for the patient [13].

### Limitations

As bone age was not routinely determined during hospitalisation, its contribution to treatment-decision-making process could not be evaluated. Additionally, limitations in our study includes the inability to identify the duration of brace use and assessing patients' long- term deformity and neurological complications.

### Conclusion

Pediatric spine traumas are rare lesions that can be overlooked. The treatment plan should be made taking into account the growth of the spine. Larger patient groups with longer follow-up periods are needed to establish a treatment protocol for pediatric spinal trauma.

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#### REFERENCES

- Herren C, Jarvers JS, Jung MK, Blume C, Meinig H, Micheal R et al. Paediatric spine injuries in the thoracic and lumbar spine-results of the German multicentre CHILDSPINE study. *Eur Spine J.* 2024;33(4):1574-84. doi: 10.1007/s00586-023-07822-1
- Sayama C, Chen T, Trost G, Jea A. A review of pediatric lumbar spine trauma. *Neurosurg Focus.* 2014;37(1):E6. doi: 10.3171/2014.5.FOCUS1490.
- Gavira N, Amelot A, Cook AR, Hamel A, Buffenoir K, Cristini J. Thoracolumbar spinal fracture in children: Conservative or surgical treatment? *Neurochirurgie.* 2022;68(3):309-14. doi: 10.1016/j.neuchi.2021.06.014.
- Huisman TA, Wagner MW, Bosemani T, Tekes A, Poretti A. Pediatric spinal trauma. *J Neuroimaging.* 2015;25(3):337-53. doi: 10.1111/jon.12201.
- Dolgun, H., Emrahoğlu, M.E., Yılmaz, E.R. et al. Epidemiology of pediatric thoracolumbar spinal fractures and associated injuries: a single-center experience. *Childs Nerv Syst.* 2025;41(1):106. doi: 10.1007/s00381-025-06762-z.
- Gopinathan NR, Viswanathan VK, Crawford AH. Cervical Spine Evaluation in Pediatric Trauma: A Review and an Update of Current Concepts. *Indian J Orthop.* 2018;52(5):489-500. doi: 10.4103/ortho.IJOrtho\_607\_17.
- Bonsignore-Opp L, O'Donnell J, Agha O, Bach K, Metz L, Swarup I. Evaluation and Management of Thoracolumbar Spine Trauma in Pediatric Patients: A Critical Analysis Review. *JBJS Rev.* 2024;12(6). doi: 10.2106/JBJS.RVW.24.00045.
- Mendoza-Lattes S, Besomi J, O'Sullivan C, Ries Z, Gnanapradeep G, Nash R et al. Pediatric Spine Trauma in the United States--Analysis of the HCUP Kid'S Inpatient Database (KID) 1997-2009. *Iowa Orthop J.* 2015;35:135-9. PMID: 26361456
- Gündoğdu EB, Şimşek O, Tüzün Y. Childhood Spinal Trauma and Treatment: Differences from Adult Cases. *Türk Nöroşir Derg.* 2023;33(1):31-40.
- Saul D, Dresing K. Epidemiology of vertebral fractures in pediatric and adolescent patients. *Pediatr Rep.* 2018;10(1):7232. doi: 10.4081/pr.2018.7232.
- Katar S, Ozturk PA, Ozel M, Cevik S, Evran S, Baran O, et al. Pediatric spinal traumas. *Pediatr Neurosurg.* 2020;55(2):86-91. doi: 10.1159/000508332.
- Cirak B, Ziegfeld S, Knight VM, Chang D, Avellino AM, Paidas CN. Spinal injuries in children. *J Pediatr Surg.* 2004;39(4):607-12. doi: 10.1016/j.jpedsurg.2003.12.011.
- Piazza M, Schuster J. Timing of Surgery After Spinal Cord Injury. *Neurosurg Clin N Am.* 2017;28(1):31-9. doi: 10.1016/j.nec.2016.08.005.
- Mahan ST, Mooney DP, Karlin LI, Hresko MT. Multiple level injuries in pediatric spinal trauma. *J Trauma.* 2009;67(3):537-42. doi: 10.1097/TA.0b013e3181ad8fc9
- Behar S. Cervical spine injury in infants and children. In: Leonard JC editor. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide.* USA: Cengage Publisher Services, 2022. Chapter 112.
- Angelliaumea A, Simonc AL, Boissièreb L, Boutya A, Gauzyd JS, Vitalb JM et al. Conservative treatment of pediatric thoracic and lumbar spinal fractures: Outcomes in the sagittal plane. *J Pediatr Orthop B.* 2017;26(1):73-9. doi: 10.1097/BPB.0000000000000329.
- Parisini P, Di Silvestre M, Gregg T. Treatment of spinal fractures in children and adolescents: long-term results in 44 patients. *Spine (Phila Pa 1976).* 2002;27(18):1989-94. doi: 10.1097/00007632-200209150-00006.
- Sarıılmaz K, Özkunt O, Fatih D. Pediatric thoracolumbar spine fractures. *J Turk Spinal Surg* 2016;27(2):111-6