Volume: 27, Issue:2, April 2016 pp: 111-116 REVIEW ARTICLE / DERLEME

PEDIATRIC THORACOLUMBAR SPINE FRACTURES

ÇOCUK TORAKOLOMBER OMURGA KIRIKLARI

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SUMMARY:

Pediatric spinal trauma is unique. Moreover, the trauma patterns differ in each age group. Cranio-cervical spine injuries seen in before the age of 8, however, thoracolumbar fractures seen in the adolescence period. Most common injury pattern is sport related injuries and traffic accidents. Initial evaluation should include Advanced Trauma Life Support protocols. Plain radiography and computer tomography is the first line of imaging. Magnetic resonance imaging is sensitive for disco-ligamentous and spinal cord injuries. The treatment depends on the fracture pattern and neurologic problems. Overall, most pediatric injuries of thoracolumbar spine have good to excellent long-term outcomes. In this review, a summary of pediatric thoracolumbar spine fractures is discussed.

Key words: Spine fracture, pediatric, diagnosis, treatement, surgery

Level of evidence: Review article, Level V

ÖZET:

Pediatrik spinal travmalar kendine özgüdür. Ek olarak travma şekli yaş grupları arasında bile değişkendir. Kranioservikal omurga yaralanmaları daha çok 8 yaş öncesinde görülürken, torakolomber kırıklar daha çok adolesan dönemde görülür. En sık yaralanma şekli sporla ilişliki yaralanmalar ve trafik kazalarıdır. İlk değerlendirme İleri Travma Yaşam Desteği protokollerini içermelidir. Düz grafiler ve bilgisayarlı tomografi görüntülemede ilk basamaktır. Manyetik rezonans diskoligamantöz ve spinal kord yaralanmalarına spesifiktir. Tedavi şekli yaralanmaya ve nörolojik duruma gore değişir. Genel olarak peditarik torakolomber omurga kırıklarının sonuçları iyidir. Bu derlemede, pediatrik torakolomber omurga kırıkları özet bir şekilde tartışılmıştır.

Anahtar Kelimeler: Omurga kırıkları, çocuk, tanı, tedavi, cerrahi

Kanıt Düzeyi: Derleme, Düzey V

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Received: 1st December, 2016.
Accepted: 14th January, 2016.

INTRODUCTION:

Thoracolumbar spinal trauma in pediatric population is a rare but separate entity and have differences from adults due to anatomical, anthropometric, injury pattern, clinical presentation, imaging and management. Some of these injuries may be life-threatening and may cause big disabilities, thus, early diagnosis and appropriate management of these injuries is essential.

EPIDEMIOLOGY:

Spine fractures in the pediatric population occur 2% to 5% of all spine injuries[9]. The majority of the pediatric spine fractures occur at the upper cervical spine younger than 8 years of age due to ligamentous laxity, horizontal orientation of vertebral facets, wedge shaped vertebral body, underdeveloped paraspinal muscles and large head-to-torso ratio[24]. In contract, the adolescent patients present similar injury patterns with the adults. Thoracolumbar injuries in the pediatric population occur primarily between the ages of 10 and 16[12]. The majority of the patients are male (63%)[8]. The most common mechanism of injuries to the thoracolumbar spine is sports-related injuries and motor vehicle accident (MVA). Other mechanisms include falls, child abuse, pathological fractures, insufficiency fractures and gun-shot injuries[28].

ANATOMY AND PATHOPHYSIOLOGY:

The anatomic and biomechanical differences between pediatric and adult spine result in different injury patterns. Each pediatric thoracolumbar vertebra has 3 ossification center; one central and two neural arches. Fusion occurs between 2-6 years of age. The growing vertebrae has two physis; superior and inferior end plates. They begin to ossify between the ages of 4-7 and fusion begins at the age of 12-14 and compete fusion occurs at the age of 21-25[32].

Before that age, physeal lines may be interpreted as fractures lines (Figure-1). Before the complete fusion, the apophyeal ring and physis are relatively weaker and more susceptible to injury than the surrounding tissues.

Similar to subaxial cervical spine, thoracolumbar spine has horizontal oriented facet joints. The ligaments, discs and soft tissues are laxer than the adult spine. These elastic properties explain the increase incidence of spinal cord injury without radiographic abnormalities in children[15].

MECHANISM OF INJURY:

Flexion, distraction and shear forces are the main mechanism of thoracolumbar injuries. Flexion injuries result in compression fracture, which involves the anterior column of the vertebrae. Greater forces result in burst fracture, involves both anterior and middle column and may result retropulsion of the fractured fragments into the spinal canal. A distraction injury may occur with greater degrees of flexion and usually occur during rapid deceleration of an automobile in a patient uses a seat belt (seat belt injury). This kind of distraction results in posterior bony and ligamanteous injuries.

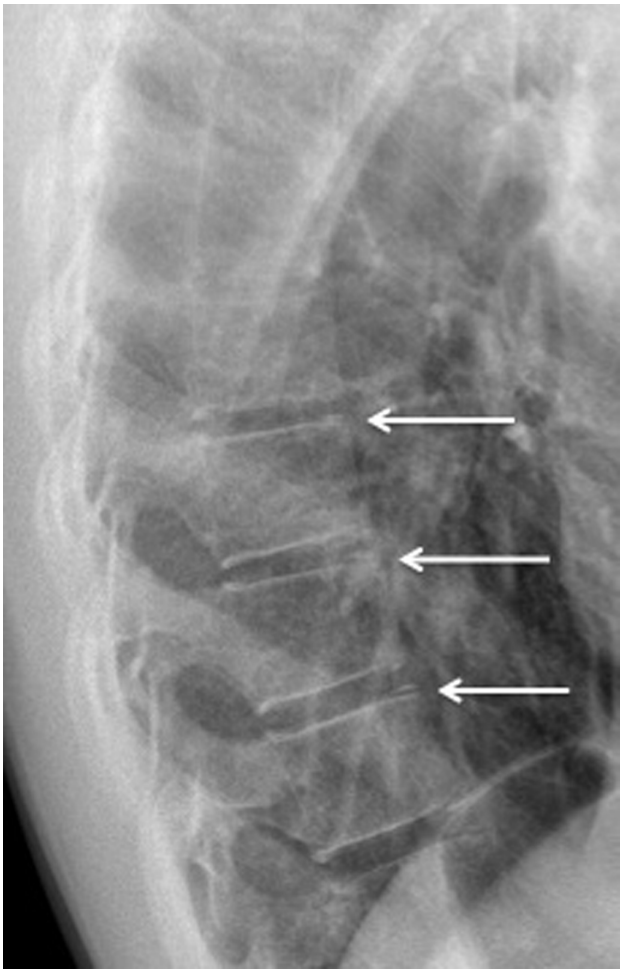

Figure-1. 14 year-old girl. White arrows show vertebral physeal lines.

HISTORY AND CLINICAL EVALUATION:

The initial evaluation of the pediatric spine injuries should include Advanced Trauma Life Support (ATLS) protocols and the patient should be kept in a immobilized position until spinal injuries can be ruled out[28]. Thoracolumbar injuries are often a result of high-energy trauma and associated skeletal, cranial and visceral injuries are frequent[27]. For this reason, multidisciplinary approach with other clinical trauma services is essential.

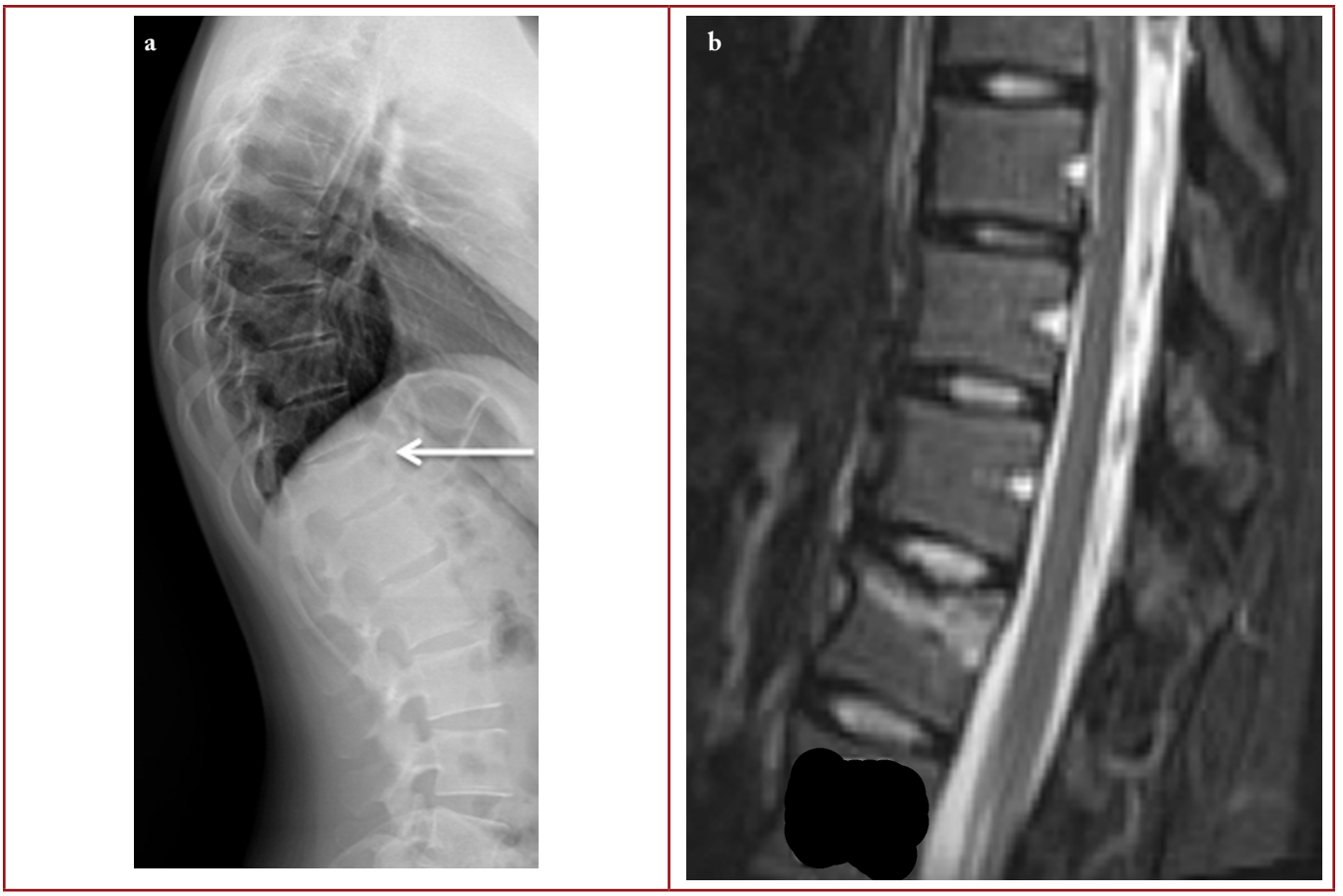

Figure-2. 17 year-old girl. **a)** White arrow shows T12 compression fracture. **b)** T2-weighted sagittal MRI shows T12 bone edema and compression fracture.

If possible, a detailed history should be obtained after ATLS approach. Mechanism of injury, neurological complaints, any other extraspinal symptoms should be obtained.

Most common physical findings with thoracolumbar injuries among children are tenderness, bruising, skin injuries, crepitus and step-offs or gaps between spinous processes[28]. 'Lap belt' sign, bruising or abrasions on the abdomen along the site of the lap portion of safety belt, is associated with a high rate of injury to the abdominal organs in 50% to 84% and spinal fracture in 15% to 50% of pediatric patients[1,23] (Figure-2, 3).

A through motor and sensorial neurological examination should be performed and documented in all patients with suspected injury to the spine. Rectal sensation, tone, bulbocavernosus reflex and bleeding also should be examined. The absence of the reflex with complete absence of motor function indicates spinal shock and no definitive statement can be made about the neurological deficit[11]. In case of the recovery of the bulbocavernosus reflex with the persistence of complete absence of the motor deficit, it is unlikely that significant neurological function will ever return.

IMAGING:

For adult trauma patients, there is evidence-based recommendations exist. In case of high velocity injury, decreased level of consciousness, associated head injury, pelvis-lower extremity trauma, back and midline tenderness, local signs of thoracolumbar spine injury, abnormal neurological signs, cervical spine fracture, Glaskow Coma Scale (GCS) <15, major distracting injury or alcohol/drug intoxication, the thoracolumbar spinal imaging is recommended[16,31].

There is no consensus on which pediatric trauma patients need thoracolumbar spinal radiographic evaluation. Recommendations for imaging of the thoracolumbar spine include GCS<15, multisystem injuries, positive findings on clinical examination, suspected nonaccidental trauma and a preverbal child with a high-risk mechanism of injury[12,18,28]. Most of the pediatric spinal injuries are multilevel, thus, whole spine imaging is recommended when an abnormal radiographic finding is identified within any level[28].

Figure-3. Seat belt sign

Analyzing the stability of the fracture is very important, because it can guide the management. Suggestive imaging signs of instability (Table-1)[2] are generally for adult thoracolumbar spine fractures, however, some authors suggest that they may be applies to the children older than 9 years[4,8,13,30].

Table-1. Radiographic Instability Signs of Thoracolumbar Spine Fracture in Pediatric Patients

• 40-50 % loss of vertebral body height
• 15 °-30° of kyphotic angulation
• 35-50 % spinal canal compromise by fracture fragments
• >2.5 mm translation of the vertebral body in any plane
• Widening of the pedicles
• Bilateral facet dislocations
• Abnormal widening of spinous processes, facets, or laminae

Most of thoracolumbar fractures can be visualized by plain radiographs. Loss of vertebral body height, kyphotic angulation, translation of the vertebral body, interpedicular widening, abnormal widening of spinous prosesses, facets and laminas are some of the radiographic findings of thoracolumbar pediatric spinal injuries (Figure-2).

CT scan is especially needed for osseous component of the spine for example can evaluate spinal canal after burst fracture. MRI preferred for evaluating spinal injuries to assess the cord injury[5,8]. Interpedicular widening on the AP projection and small cortical defects at posterosuperior corner of the vertebral body on the lateral projection can be seen on conventional radiography in burst fractures. But leading cause of missed injury and subsequent neurologic deterioration in trauma patients, supporting the argument for increased use of CT and MRI[21]. Although plain film radiographic and CT images may elucidate the integrity of the posterior ligamentous complexes of the spine, MRI is more reliable and recommended when compression fractures of the vertebral body present with a loss of more than 50% in anterior height[22].

Spinal cord injury without radiographic abnormality (SCIWORA), is a condition of objective signs of acute spinal cord injury in the absence of spinal column findings on plain radiographs and/or computed tomography (CT)[25]. The incidence is from 4% to 67% of all pediatric spinal traumas[6,26]. The most common region for SCIWORA is cervical spine, however, 13% of lesions are within the lowest thoracic spine[30]. The pathogenesis is related with the higher laxity of the bony and ligamentous structures compared with the spinal cord. In the setting of spinal injury, bony and ligamentous structures can undergo significant stretching, however, the spinal cord may be injured.

CLASSIFICATION:

Thoracolumbar fractures in children are uncommon but cause significant morbidity and mortality. Two classification systems for thoracolumbar spine injuries are discussed.

Denis described a three-column classification system. It divides column of vertebrae to three parts; anterior, middle and posterior. This system used to classify thoracolumbar fractures as compression fractures, burst fractures, flexion-distraction injuries or fracture-dislocations. He also classified the stability of these fractures based on number of columns affected[10].

TLICS scale help analyze and manage fracture patterns into three axes: **1)** injury morphology, **2)** integrity of the posterior ligamentous complex, and **3)** neurologic status (Table-2)[33].

The TLICS system based on score about value of injury. Patients with a score of 3 or less are generally treated nonoperatively but score of 5 or greater generally require surgical fixation. Although TLICS system is a reliable for classifying and managing adult thoracolumbar fractures, yet to be validated for pediatric patients[29].

Table-2. Thoracolumbar Injury Classification and Severity Scoring System

Characteristic	Points
Morphology	
Compression	1
Burst	2
Rotation/translation	3
Distraction	4
Disruption of the Posterior Ligamentous Complex	
Intact	0
Suspected	2
Disrupted	3
Neurologic Status	
Intact	0
Nerve root	2
Cord, conus medullaris: Complete	2
Cord, conus medullaris:Incomplete	3
Cauda equina	3

MANAGEMENT:

Stable injuries of the thoracolumbar spine in pediatric population can be treated non-operatively, often without an orthosis[19,30]. Additionally, on the basis of good healing potential of younger patients, nonsurgical management of unstable fractures in patients youger than 9 years of age is recommended by some authors, except neurological compromise, irreducible subluxation, polytrauma and brace/cast intolerance[8,30]. Non-operative management in this setting includes bed rest, bracind and casting with analgesia and myorelaxants for muscle spasm. For all non-operative management options, close follow-up is necessary to confirm fracture stability and aligment.

After adequate analgesia minor spinous process fractures, transverse process fractures, wedge compression fractures can be treated by thoracolumbosacral orthosis (TLSO) for 6 weeks[21]. Chance fractures require hyperextension casting/bracing for 8-12 weeks[22].

Children who sustain an unstable injury, such as a vertebral subluxation or a fracture dislocation, should undergo reduction in the same manner as an adult with a similar injury. Early surgical treatment, instrumentation, and fusion are mandatory for unstable fractures and injuries associated with spinal cord lesions[17,20]. In children, atraumatic spinal cord lesion may develop a deformity that mainly scoliotic, kyphotic, or lordotic in 90% of cases[3,14,20].

Children with burst fractures that result in spinal canal narrowing (greater than 25%) and kyphosis are increased risk of further canal compromise and should be considered for early correction and decompression[7,28]. Also found that non-operative treatment of burst fracture is a viable option in neurologically intact children, but progressive angular deformity occurred during the first year after the fracture[20]. As in the adult, spinal instrumentation is helpful in reducing deformity and stabilizing the fracture site. Open reduction must be accompanied by a posterior spinal fusion at least one level above and below the fracture site. Laminectomy is rarely needed because can cause kyphotic deformity during short time follow-up[34]. Spontaneous interbody fusion seldom occurs and should not bed depended on to provide long-term stability[3].

CONCLUSION:

Injury of the thoracolumbar spine are uncommon during the childhood and most arise from high-energy motor vehicle accidents. Because of related with significant injury, carefully clinical examination and treatment is very important. Overall, most pediatric injuries of thoracolumbar spine have good to excellent long-term outcomes.

REFERENCES:

1. Achildi O, Betz RR, Grewal H. Lapbelt injuries and the seatbelt syndrome in pediatric spinal cord injury. *J Spinal Cord Med* 2007; 30(Suppl 1): S21-24.
2. Al-Mansoori K, Oetgen ME. Fractures of the thoracolumbar spine in pediatric patients. *Orthop Know Online J* 2015; 13.
3. Aufdermaur M. Spinal injuries in juveniles. Necropsy findings in twelve cases. *J Bone Joint Surg* 1974; 56-B: 513-519.
4. Bailey CS, Urquhart JC, Dvorak MF, Nadeau M, Boyd MC, Thomas KC, Kwon BK, Gurr KR, Bailey SI, Fisher CG. Orthosis versus no orthosis for the treatment of thoracolumbar burst fractures without neurologic injury: a multicenter prospective randomized equivalence trial. *Spine J* 2014; 14: 2557-2564.
5. Bakhsheshian J, Dahdaleh NS, Fakurnejad S, Scheer JK, Smith ZA. Evidence-based management of traumatic thoracolumbar burst fractures: a systematic review of nonoperative management. *Neurosurg Focus* 2014; 37: E1.
6. Brown RL, Brunn MA, Garcia VF. Cervical spine injuries in children: a review of 103 patients treated consecutively at a level 1 pediatric trauma center. *J Pediatr Surg* 2001; 36: 1107-1114.

7. Carreon LY, Glassman SD, Campbell MJ. Pediatric spine fractures: a review of 137 hospital admissions. *J Spin Dis Tech* 2004; 17: 477-482.

8. Clark P, Letts M. Trauma to the thoracic and lumbar spine in the adolescent. *Can J Surg* 2001; 44: 337-345.

9. Daniels AH, Sobel AD, Eberson CP. Pediatric thoracolumbar spine trauma. *J Am Acad Orthop Surg* 2013; 21: 707-716.

10. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine* 1983; 8: 817-831.

11. Ditunno JF, Little JW, Tessler A, Burns AS. Spinal shock revisited: a four-phase model. *Spinal Cord* 2004; 42: 383-395.

12. Dogan S, Safavi-Abbasi S, Theodore N, Chang SW, Horn EM, Mariwalla NR, Rekate HL, Sonntag VK. Thoracolumbar and sacral spinal injuries in children and adolescents: a review of 89 cases. *J Neurosurg* 2007; 106: 426-433.

13. Gnanenthiran SR, Adie S, Harris IA. Nonoperative versus operative treatment for thoracolumbar burst fractures without neurologic deficit: a meta-analysis. *Clin Orthop Rel Res* 2012; 470: 567-577.

14. Hachen HJ. Spinal cord injury in children and adolescents: diagnostic pitfalls and therapeutic considerations in the acute stage [proceedings]. *Paraplegia* 1977; 15: 55-64.

15. Hamilton MG, Myles ST. Pediatric spinal injury: review of 174 hospital admissions. *J Neurosurg* 1992; 77: 700-704.

16. Hsu JM, Joseph T, Ellis AM. Thoracolumbar fracture in blunt trauma patients: guidelines for diagnosis and imaging. *Injury* 2003; 34: 426-433.

17. Jackson RW. Surgical stabilisation of the spine. *Paraplegia* 1975; 13: 71-74.

18. Junkins EP, Jr., Stotts A, Santiago R, Guenther E. The clinical presentation of pediatric thoracolumbar fractures: a prospective study. *J Trauma* 2008; 65: 1066-1071.

19. Karlsson MK, Moller A, Hasserius R, Besjakov J, Karlsson C, Ohlin A. A modeling capacity of vertebral fractures exists during growth: an up-to-47-year follow-up. *Spine* 2003; 28: 2087-2092.

20. Lalonde F, Letts M, Yang JP, Thomas K. An analysis of burst fractures of the spine in adolescents. *Am J Orthop* 2001; 30: 115-120.

21. McPhee IB. Spinal fractures and dislocations in children and adolescents. *Spine* 1981; 6: 533-537.

22. Moller A, Hasserius R, Besjakov J, Ohlin A, Karlsson M. Vertebral fractures in late adolescence: a 27 to 47-year follow-up. *Eur Spine J* 2006; 15: 1247-1254.

23. Newman KD, Bowman LM, Eichelberger MR, Gotschall CS, Taylor GA, Johnson DL, Thomas M. The lap belt complex: intestinal and lumbar spine injury in children. *J Trauma* 1990; 30: 1133-1138; discussion 1138-1140.

24. Nitecki S, Moir CR. Predictive factors of the outcome of traumatic cervical spine fracture in children. *J Pediatr Surg* 1994; 29: 1409-1411.

25. Pang D, Wilberger JE, Jr. Spinal cord injury without radiographic abnormalities in children. *J Neurosurg* 1982; 57: 114-129.

26. Roche C, Carty H. Spinal trauma in children. *Pediatr Radiol* 2001; 31: 677-700.

27. Rush JK, Kelly DM, Astur N, Creek A, Dawkins R, Younas S, Warner WC, Jr., Sawyer JR. Associated injuries in children and adolescents with spinal trauma. *J Ped Orthop* 2013; 33: 393-397.

28. Santiago R, Guenther E, Carroll K, Junkins EP, Jr. The clinical presentation of pediatric thoracolumbar fractures. *J Trauma* 2006; 60: 187-192.

29. Sayama C, Chen T, Trost G, Jea A. A review of pediatric lumbar spine trauma. *Neurosurg Focus* 2014; 37: E6.

30. Slotkin JR, Lu Y, Wood KB. Thoracolumbar spinal trauma in children. *Neurosurg Clin North Am* 2007; 18: 621-630.

31. Stanislas MJ, Latham JM, Porter KM, Alpar EK, Stirling AJ. A high risk group for thoracolumbar fractures. *Injury* 1998; 29: 15-18.

32. Taylor JR. Growth of human intervertebral discs and vertebral bodies. *J Anat* 1975; 120: 49-68.

33. Vaccaro AR, Lehman RA, Jr., Hurlbert RJ, Anderson PA, Harris M, Hedlund R, Harrop J, Dvorak M, Wood K, Fehlings MG, Fisher C, Zeiller SC, Anderson DG, Bono CM, Stock GH, Brown AK, Kuklo T, Oner FC. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. *Spine* 2005; 30: 2325-2333.

34. Yasuoka S, Peterson HA, MacCarty CS. Incidence of spinal column deformity after multilevel laminectomy in children and adults. *J Neurosurg* 1982; 57: 441-445.