Traumatic spine injuries in children. Experience on 434 cases and therapeutic perspectives

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Abstract: Traumatic spine injuries in pediatric patients have a low incidence, mainly due to a more flexible spine and is a specific matter in comparison to spinal injury in adults. Pediatric spine fractures constitute 1 to 3% of all pediatric fractures. Between 20 % and 60% of the fractures occur in the lumbar and thoracic spine. These spine injury appeared most frequently in sport events, followed by traffic events and accidental falling. The vast majority of the children with spinal trauma had grade D and E lesions on Frankel scale and had a good recovery in 1 to 3 months after the event. Prognosis and outcome is better in children with spine trauma, reducing toward adolescence and in young adults and the death rate was extremely low compared to the adult population.
Key words: pediatric spine fractures, spinal cord injuries.

Introduction

Traumatic injury of the spine in children is a specific matter in comparison to spinal injury in adults. In young children, there is a larger head relative to the cervical spine and supporting structures, there is a higher elasticity (eight times) of the spine compared to the spinal cord. Also, there is a greater mobility of the pediatric bones and ligaments. By 15 years of age, the spine undergoes progressive anatomical and biochemical changes. Spinal stiffness increases gradually together with the growth of the ossification centers and the spinal synchondrosis fusion. Thus, injuries of the spine in children result in age specific traumatic patterns.

Taking into account the child's age at the time of injury, neonatal and infant spine injury is related to the obstetrical trauma, where the upper cervical spine is mostly involved, atlanto-occipital dislocation occurring with high frequency. Spinal injuries also occur in abused children.

For children under three years old, injuries of the upper cervical spine involving the spinal cord occur in 47% of cases, and vertebral injuries occur in 53% of cases. For the lower cervical spine, injuries implying the spinal

cord occur in 53% and injuries affecting the vertebrae in 47% of the patients.

In children under 8 years old, the cervical spine is more often affected (70 to 87%), atlanto-oocipital dislocation being most frequently encountered, presenting a high mortality rate (70 to 100%). Spinal trauma in children over 8 years old also affects the other levels of the spine and the trauma patterns start to be more similar to the adult population.

In pediatric spine injuries, the standard techniques of immobilization and transport may induce secondary lesions in the case of an unstable spine. Of great importance are the indirect signs of spinal injury in noncooperative children: chin and facial abrasions or posterior ligament defects on spinal clinical examination. Imaging is very important but should be carefully assessed.

Pediatric spine fractures constitute 1 to 3% of all pediatric fractures. Between 20 % and 60% of the fractures occur in the lumbar and thoracic spine. The incidence is higher in the lumbar spine in older children.

Material and methods

Our study includes 434 pediatric patients presenting with traumatic spine injuries, admitted in the Spinal Surgery and Pediatric Neurosurgery departments of the Bagdasar-Arseni Clinical Hospital, from 2003 to 2013. The diagnosis was made by clinical and imaging exams. The patients were identified in the hospital's data base, using the terms vertebral/spinal cord trauma, and the patients' medical records were taken from the hospital archive. The study group was divided into 4 age-related subgroups (0 to 3 years old, 4 to 7 years old, 8 to 14 years old and 15 to 18 years old) taking into account the age related risk factors. The degree of neurological deficits was established using the Frankel Classification grading system.

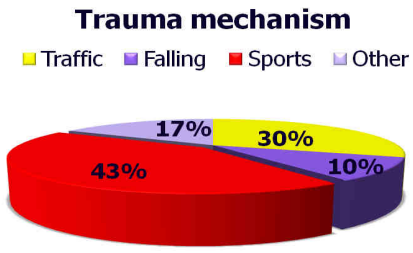

Figure 1 - Classification by trauma mechanism

Results

Our study concluded that spine injury appeared most frequently in sport events, followed by traffic events and accidental falling (fig.1). Other accidents resulted in spine injury in 17% of patients. More than half of the injuries occurred in boys and the sex ratio was 1.48:1.

The majority of the cases didn't require surgical intervention. Still, 152 patients were surgically treated. Conservative treatment included all therapeutical options from pain killers to cervical collars.

Based on the information extracted from the medical files, we could establish distinct injury profiles, explained by anatomical and biomechanical features, which differentiates the young patient with an immature spine from the adolescent with an adult-like spine.

Still, missed diagnosis at first evaluation

was found in 24% of the children younger than 8 years old and in 15% patients over 9 years old, mostly cervical lesions.

Boys are more prone to spinal trauma. The cervical spine was the most frequent spine level involved, due to specific anatomical and functional features of children (learning to walk, run, climb). The cervical lesions appeared in 56,5% of cases (245 cases), thoracic lesions in 18% of the cases (78 cases) and lumbar lesions in 25.5% of the cases (111 cases). Sport and falling accidents were the main cause, encountered in 53% of the patients.

It is important to emphasize that spine concussions are almost equal in proportion with the rest of the other lesions (210 cases versus 234 cases) (figure 2).

The vast majority of the children with spinal trauma had grade D and E lesions on Frankel scale (Table 1) and had a good recovery in 1 to 3 months after the event.

In 66% of the cases the treatment was conservative (figure 3).

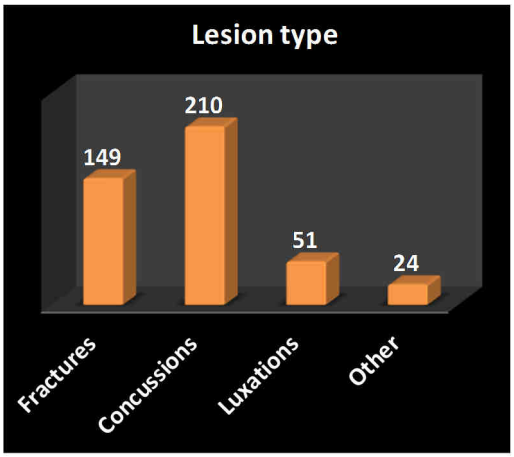

Figure 2 - Distribution by type of lesion

TABLE I

Frankel scale classification in our study group

Nr. crt.	Neurological injury	Number of cases	% of cases
1	Frankel A	57	13,1%
2	Frankel B	25	5,7%
3	Frankel C	47	10,8%
4	Frankel D	142	32,7%
5	Frankel E	163	37,5%

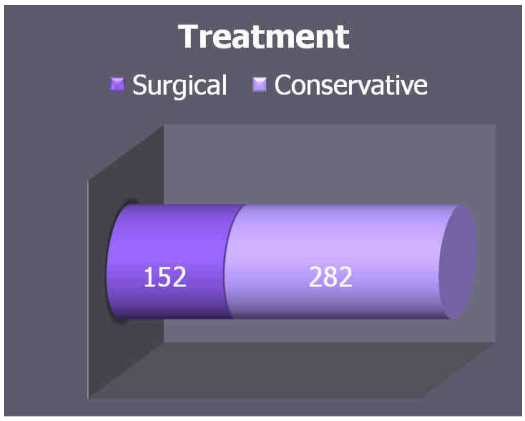

Figure 3 - Type of treatment

Case reports

Case presentation 1

An 11 year old boy who suffered an electrocution accident was admitted to the Pediatric Neurosurgical Department with a Frankel C neurological lesion by a C1/C2 dislocation. Conservative treatment was decided by hallo west immobilization, resulting in slow recovery of the neurological deficits presented at admission, in cca. 5 months (figure 4).

Case presentation 2

A 16 year old girl had fallen from a height, followed by vertebral and spinal cord trauma,

with a Frankel C neurological lesion produced by a T10 fracture. She was operated on and full recovery was obtained 4 months after surgery (figure 5).

Case presentation 3

This case relates to a 12 years old girl who was involved in a traffic accident and had a L5 fracture. The treatment was conservative (figure 6).

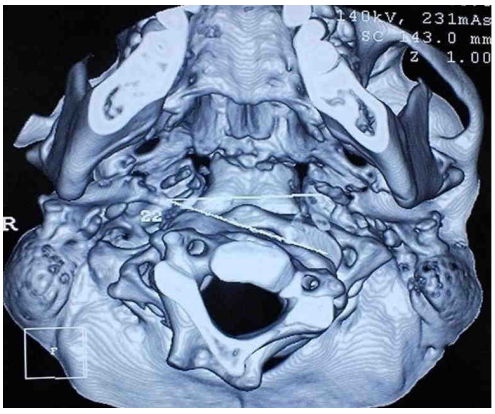

Figure 4a - CT scan reconstruction showing C1/C2 dislocation

Figure 4b - Cervical spine MRI, sagittal view

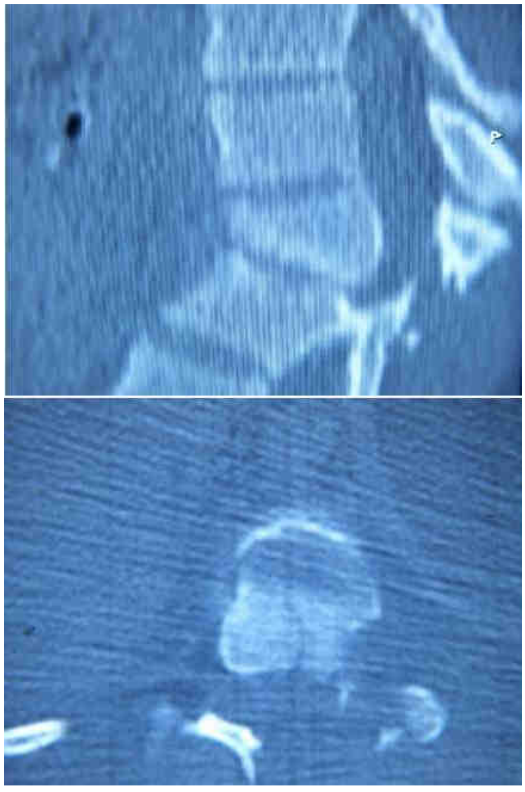

Figure 5a - CT scan – sagittal (upper) and axial (lower) sections

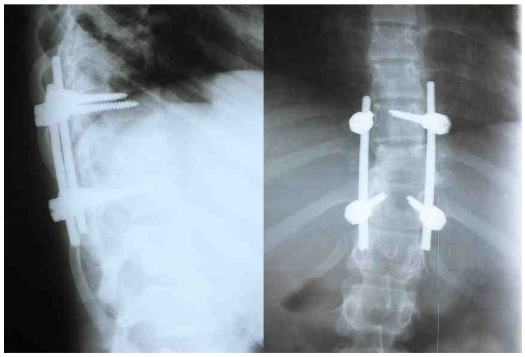

Figure 5b - Postoperative radiographic aspect

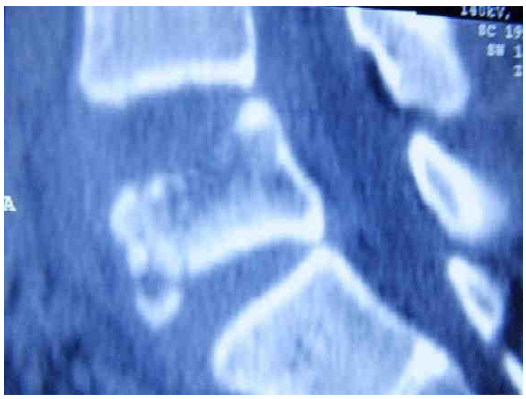

Figure 6a - MRI sagittal view

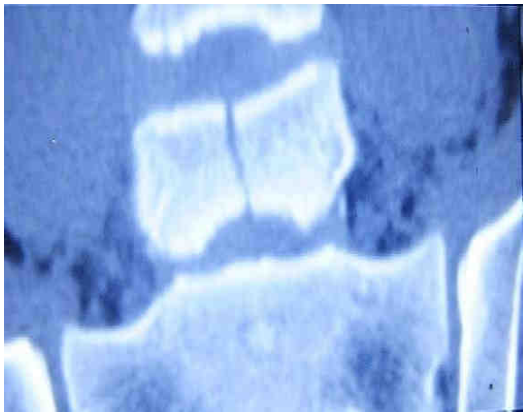

Figure 6b - Coronal view

Discussions

Traumatic spine injuries in pediatric patients have a low incidence, mainly due to a more flexible spine. The anatomical characteristics of children allow a better applicability of the conservative treatment. If we compare pediatric and adult spine injury we can conclude that identical situations lead to different neurological deficits. The NEXUS criteria for C-spine imaging in adult population takes into consideration the presence of focal neurological deficit, of midline spinal tenderness, of altered level of consciousness, of intoxication and of distracting injury. If none of these is present, the patient can be cleared. The clearance of the paediatric patients is more difficult than in adult patients therefore the NEXUS criteria of imagery were accordingly modified. Particularly, for children between 0 and 3 years old who sustained a cervical spine trauma, assessment is hindered by the poor cooperation of a scared child. Anderson and al. (2010) tried to coin a management algorithm for children less than 3 years old. The children with a cervical collar with positive imagery (X-ray or CT-scan if the X-ray is inconclusive) are sent to neurosurgery, the others are clinically evaluated as to whether there is spinal cord injury or a high-speed injury, cervical MRI with STIR or T2 fat suppression. If there is no lesion then the spine is clear, if there is a lesion the patient will be referred to the neurosurgeon. If inconclusive, fluoroscopy in flexion and extension should be done. The intubated patient should wait till they become fully awake then the MRI should be performed.

New therapeutic perspectives are opened by the studies on the predictive biomarkers for traumatic SCI. In acute traumatic spinal cord injury the phosphorylated form of the high-molecular-weight neurofilament subunit (pNF-H) in CSF can be a predictive biomarker because of its values pattern can show the reducing of the secondary lesion. Studies have shown the complete SCI cases with a favorable evolution had a specific pattern of daily values of pNF-H: a sudden increase up to a maximum value then a progressive decrease until normal. The cases with unfavorable outcome or

neurological stationary had two patterns: an increase to a plateau of pNF-H values or a progressive increase up to a peak and then it was followed by a progressive decrease to normal values. After decompression and stabilization during the first 24 hours we can use the predictive pattern of daily values of pNF-H in cases with unfavorable pattern. The second microneurosurgery in SCI site can create favorable conditions for functional recovery of the remaining spinal cord.

Conclusions

Prognosis and outcome is better in children with spine trauma, reducing toward adolescence and in young adults. The prognosis depends on the severity of spinal cord injuries, with good neurofunctional recovery, noticeably increased in the pediatric population compared to the adult population. The death rate was extremely low compared to the adult population, with only 6 deceased patients out of 434 cases.

Acknowledgments

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