International Journal of Neurosurgery
2021; 5(1): 13-18
http://www.sciencepublishinggroup.com/j/ijn
doi: 10.11648/j.ijn.20210501.14
ISSN: 2640-1940 (Print); ISSN: 2640-1959 (Online)

Diagnostic, Therapeutic and Evolutionary Peculiarities of Spinal Trauma in Children in Sub-Saharan Africa: Experience of Senegal

Faye Mohameth[1], Adolphe Bimangou[1], Mualaba Celebre[1, *], El Hadji Cheikh Ndiaye Sy[1], Diop Abdoulaye[2], Barry Lounceny Fatoumata[1], Mhaks Malangu[1], Ba Momar Code[1]

[1]Neurosurgery Department, Fann Teaching Hospital, Cheikh Anta Diop University, Dakar, Senegal

[2]Neurosurgery Unit, Assane Seck University, Ziguinchor, Senegal

Email address:

mualabcl01@gmail.com (M. Celebre)

[*]Corresponding author

To cite this article:

Faye Mohameth, Adolphe Bimangou, Mualaba Celebre, El Hadji Cheikh Ndiaye Sy, Diop Abdoulaye, Barry Lounceny Fatoumata, Mhaks Malangu, Ba Momar Code. Diagnostic, Therapeutic and Evolutionary Peculiarities of Spinal Trauma in Children in Sub-Saharan Africa: Experience of Senegal. *International Journal of Neurosurgery*. Vol. 5, No. 1, 2021, pp. 13-18. doi: 10.11648/j.ijn.20210501.14

Received: February 14, 2021; **Accepted**: February 24, 2021; **Published**: April 7, 2021

Abstract: Introduction: Spinal trauma in children is rare, accounting for 1 and 10% of all spinal traumas. They constitute an entity in their own right due to the injuries they cause. Difficulties (diagnostic) and modalities (therapeutic), different from those of adults the growth of children. The lack of studies in Sub-Saharan Africa leads us to carry out this study focused on the traumatic spine of the child. Patients and Methods: Over a period of 8 and a half years from January 2012 to June 2020, we retrospectively studied 44 cases involving 4 Senegalese hospitals, 3 of which were in the capital and 1 in the province, including children up to the age of 16 who had suffered spinal trauma. Results: Forty-four children were retained, a frequency of 7.11%, with an average age of 10.5 years; sex ratio: 1.6. The most frequent aetiologies were: falls (from trees, from buildings): 41%; play accidents and accidents on public roads: 20.4% each. The average consultation time was 31.3 days. 34% of the patients were ASIA E patients. The majority of patients had performed a spine CT scan as an imaging examination, i.e. 95.4%. The most common site of injury was cervical with 61.3%. The most frequent lesions were: fractures, fracture-luxations and dislocations with 27.3%, 25% and 25% respectively. Five patients had associated lesions, i.e. 11.3% (4 head traumas, 9.1% and 1 pelvic trauma, 1.9). Most of the treatment was surgical (43% orthopaedic, 38.6%) and functional (16%). The post-therapy neurological evaluation (ASIA - backward step) was: A: 25%; B: 2.3%; C: 7%; D: 13.7%; E: 52.3%. We noted 3 deaths and 4 patients were re-operated. There were no consolidation complications such as pseudoarthrosis. Conclusion: Trauma to the spine in children, like any bone trauma, responds well to orthopaedic treatment. Deaths are often related to upper cervical spine injuries or occur in the context of polytrauma. Follow-up should be carried out over several years to detect possible complications at an early stage. Delays in treatment due to the difficulties of punctual medicalised transport remain the challenge to be met in our environment.

Keywords: Children, Spine, Trauma, Senegal

1. Introduction

Spinal trauma in children is rare, accounting for 1 and 10% of all spinal trauma. They constitute an entity in their own right due to the injuries they cause. Difficulties (diagnostic) and modalities (therapeutic) different from those of adults the growth of children. The average age of patients is generally between 8 and 14 years [2, 3].

Road accidents dominate the aetiologies and represent 20-50% [1, 2, 4, 5] (pedestrian-vehicle impact, vehicle passenger, driver of a two-wheeled vehicle), followed by sports or recreational accidents.

There is a clear male predominance [6, 7]. Some situations are unique to the child, such as neonatal trauma in dystocic (breech) births.

The lack of studies in Sub-Saharan Africa leads us to carry out this study focusing on the traumatic rachis of the child.

2. Patients and Methods

This was a retrospective study with a descriptive approach over a period of 8 and a half years from January 2012 to June 2020, conducted in 4 hospitals in Senegal, 3 in the capital and 1 in the province, including children aged 16 and under who had suffered spinal trauma. Study of 44 files of patients admitted and treated in these hospitals.

The parameters studied were frequency, age, sex, circumstances of the trauma, admission time, ASIA score, paraclinical (standard radiography, CT and magnetic resonance imaging), type of spinal lesions, type of treatment (surgical or orthopaedic), length of hospitalisation, neurological evolution, complications. The data were analysed using SPSS version 18 software.

3. Results

During the study period 759 spinal injuries of all ages were recorded, of which 54 cases of spinal injuries in children were diagnosed, of which only 44 cases were retained, a frequency of 7.11%. The average age was 10.5 years [1 to 16 years; sex ratio 1.6, 27 boys and 17 girls. The most frequent aetiologies were: falls from heights: 41%; recreational accidents and Public Road Accidents: 20.4% each, as shown in Table 1.

Table 1. *Breakdown by etiology.*

Age interval (years)				
Circumstances	**1-9**	**10-14**	**15-16**	**Total**
Falls (from trees, at building level)	5	8	5	18
Road accidents	4	1	4	9
Domestic accident	0	5	0	5
Canoe accident	0	0	1	1
Playful accident	6	2	1	9
Animal bite	0	0	1	1
Ballistic trauma	0	1	0	1
TOTAL	15	17	12	44

The mode of transport was medicalised in 61.5%. The mechanism of the trauma was most commonly bending 50%, flexion-extension and rotation respectively 13.6% as shown in Figure 1.

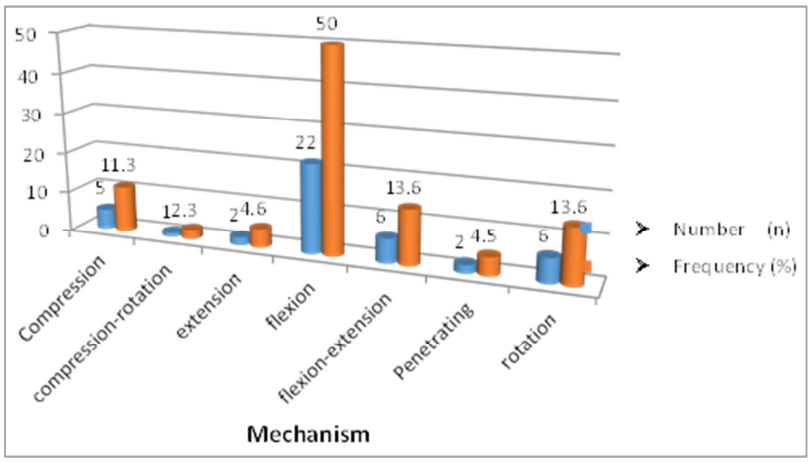

Figure 1. *Distribution of patients according to the mechanism of injury.*

The average consultation time was 31.3 days [2H - 360 days]. 34% of the patients were ASIA E as shown in Table 2.

Table 2. *Distribution of patients by ASIA Score at admission.*

ASIA admission	**N**	**%**
A	13	29,5
B	11	25
C	0	0
D	5	11,4
E	15	34,1
TOTAL	44	100

The lesions encountered were SCIWORA, sprains, dislocation, and fracture-luxations as detailed in table 3.

Table 3. *Distribution of injury type by seat and age group.*

Age (year)					
Level	**Type of injury**	**1- 9**	**10-14**	**15-16**	**Total**
	Pure fracture	4	0	0	4
	Fracture-Luxation	3	2	0	5
	Pure Luxation	4	5	1	10
Cervical	Fracture and sprain	0	1	0	1
	SCIWORA	1	1	0	2
	Herniated disc	0	0	1	1
	Spinal fracture and contusion	0	0	1	1
	Vertebro medullary wound	0	1	1	2
	SCIWORA	1	0	0	1
Dorsal	Pure fracture	0	2	1	3
	Fracture-luxation	0	2	0	2
	Vertebro-dural wound	0	1	0	1
Lumbar	Pure fracture	0	0	3	3
	Fracture-Luxation	0	0	1	1
Cervico-dorsal hinge					
	Fracture-luxation	1	0	0	1
Dorso-lumbar hinge					
	Pure fracture	0	0	2	2
	Fracture and herniated disc	0	0	1	1
	Fracture-luxation	0	2	0	2
Occipito-cervical hinge: Pure Luxation		1	0	0	1

The majority of patients had performed a CT scan as an imaging examination, i.e. 95.4%. The most frequent site of injury was cervical with 61.3%. The most frequent lesions were: fractures, fracture-luxations and dislocations with 27.3%, 25% and 25% respectively. The level of injury was represented by the cervical spine 61.3%, lumbar spine 34.4%, and cervico- dorsal hinge 2.3%. As shown in picture 1 (A, B, C).

Five patients had associated traumas, i.e. 11.3% (4 head traumas or 9.1% and 1 pelvic trauma or 1.9). The most frequent lesions were: fractures, fracture-luxations and dislocations with 27.3%, 25% and 25% respectively. The level of injury was represented by the cervical spine 61.3%, lumbar spine 34.4%, and cervico-dorsal hinge 2.3%. As shown in figure 2 (A, B, C).

Five patients had associated traumas, i.e. 11.3% (4 head traumas or 9.1% and 1 pelvic trauma or 1.9).

The treatment was mainly surgical and orthopaedic, i.e. successively 45.4% and 38.6%, with illustrative Figure 3 (A, B, C) and functional, i.e. 16%.

As far as surgical treatment is concerned, 12 patients had a posterior approach, i.e. 27.3%, and 8 patients had an anterior approach, i.e. 18.1%. During this surgery several procedures were performed as shown in table 4.

Table 4. *Breakdown of patients by surgical procedures performed according to age groups.*

Gesture	**Age (year)**			
	1 – 9	**10 – 14**	**15 - 16**	**Total**
Corporectomy + interbody graft + plate	2	0	0	2
Inter somatic graft and plate	1	2	3	6
Lacing	1	0	0	1
Laminectomy	0	1	1	2
Laminectomy and spine system	0	3	3	6
Spine system	0	2	1	3
TOTAL	4	8	8	20

The post-therapy neurological evaluation (ASIA retreat) was: A: 25%; B: 2.3%; C: 7%; D: 13.7%; E: 52.3%.

We noted 3 deaths and 4 patients were re-operated. Physiotherapy was indicated for all patients with a deficit.

4. Discussion

The biomechanical characteristics of the spine in children are different from those of adults. The pediatric spine has a greater capacity for deformation due to its elasticity and the anatomical characteristics of the discs and ligaments. Especially in patients under 8 years of age, a high head/body ratio, horizontal facet joints, immaturity of the anterior spinal wall and the absence of uncus play an important role in the deformability. While the spinal column is flexible and deformable, the spinal cord is fixed by nerve roots and meningeal sheaths [4]. Despite the immaturity of the spinal column, the pedico-astric spinal cord is at risk of developing neural lesions, particularly in the cervical region [5]. In our 8-year study we concluded that the child's cervical spine continues to retain the same characteristics. Several authors divide the child's spine according to age groups, taking into account the biomechanical implications. According to previous studies [8-10], the spine is: Before 9 years: Immature spine; Between 10 and 14 years: Intermediate stage of development; From 15 years and over: Spine resembling

that of an adult. These characteristics of maturity allow us to see the types of traumatic injuries that are common in children depending on the maturity of their spine.

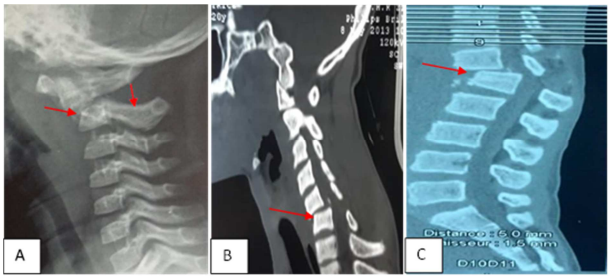

Figure 2. *(A, B, C). Illustrations of a few lesions on imaging. A: Profile incidence of a standard radiograph of the cervical spine of a 2 year old girl with an anterior tilt (arrowhead) fracture of the base of the odontoid with posterior yawning betweenC1-C2. B: CT scan of sagittal reconstruction of the cervical spine of a 15 year old boy with a C5-C6 dislocation secondary to a brawl. C: CT scan in sagittal reconstruction of the dorsolumbar spine. T12-L1 (arrowhead) fracture-luxation in a 13 year old boy.*

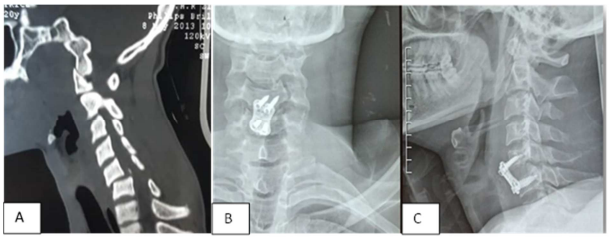

Figure 3. *(A, B, C). Pre-operative CT scan (A) and Post-operative control X-ray of the 15-year-old C5-C6 dislocation patient after a brawl. Incidence from the front (B) and profile (C) objectivizing the plate.*

Spinal injuries in the paediatric population remain rare, with reported frequencies of 1-10%, and are distinct from spinal injuries in adults. The frequency found in our series was 7.11%; this frequency is well within the range of data in the literature, which is between 1 and 10% of all spinal injuries [10-12]. An earlier study, however, still carried out in Senegal, by the author [13]**,** concluded that the overall frequency was 2.9%. This difference would be due to the evolution of the paediatric population and to certain risk factors for trauma which have evolved over time.

The average age of spinal trauma in children varies, in our series this age was 10.5 years, with extremes ranging from 1 to 16 years, which is superimposed on the series of [13] where the average age was 9.5 years and for [1], the average age was 8.3 years. The data in the literature places the age interval for the occurrence of trauma between 8 and 14 years [14, 15]. Spinal trauma in children is the prerogative of the male sex. Boys are always tempted to take more risks than girls, and this exposes them most to the risk factors for spinal trauma. In our series we found a sex ratio of 1.6**.**

The aetiologies of spinal trauma in children remain dominated by accidents on public roads and falls from heights. Several authors [11, 12**,** 10, 17, 16] as in our series, find that falls were the most predominant aetiology in children, with a frequency of 41% in our series, compared with 20.4% for play accidents and accidents on public roads, with the age group ranging from 10 to 14 years old, a real period of socialisation and discovery for a subject who is not yet aware of the consequences of the risks of exposure to activities and games which have not yet reached maturity.

Depending on the mechanism of occurrence, spinal injuries can occur in flexion, extension, rotation and distraction. In our study, flexion was the most common traumatic mechanism, with 22 cases (50%), which is in line with those found by the author [11]. The existence of spinal levels with high mobility, namely the cervical and lumbar segments where most movement occurs, is the reason for the predominance of injuries at this level.

The collection, protection and transport of patients play a very important role in the management of spinal trauma. In developed countries, this transport is carried out under the assistance of medical ambulances by well-trained personnel. In our study, 18 patients (41%) were transported by hospital ambulances. Failure to comply with transport measures puts the patient at risk, ranging from a functional to a vital prognosis depending on the level and severity of the injuries.

The clinical presentation of trauma to the child's spine is polymorphic, including simple spinal pain, with signs of sensitivomotor and genito-sphincterial damage. Clinical evaluation in the paediatric environment remains a challenge, especially in very young children because of the particular immaturity of the sphincter controls.

In our series, 40 patients or 91% had a rachialgia as the dominant symptom. The existence of neurological signs depends on the degree of shock to the spine.

This is because the biomechanical characteristics of the child's spinal column, which are supposed to protect them, are better for low-energy shocks but not in the circumstances of high-energy trauma, which is responsible for injuries with neurological signs.

The authors [17, 10] had also found this predominance of deficit cases to be 63.4% and 88.7% respectively.

The frequency of neurological impairment of patients in our series was 66%, corresponding to 29 children, which represented more than half of the cases, divided into the 10 to14 age group with 14 cases, i.e. 48.2% of the 29 children, followed by the 1 to 9 age group, which had 8 cases, i.e. 27%, with a neurological deficit, a result which is extremely contrary to those of [10], where the 15 to 18 age group was the most affected, with 151 cases, i.e. 83.4% of the total number of patients with a deficit, followed by the 10 to 14 age group, which had 19 cases, i.e. 10.4%.

The paraclinical diagnosis of a child's traumatic spine starts with the standard X-ray, CT scan and magnetic resonance imaging of the entire spine. In our series, all patients had performed at least one imaging: Standard X-ray in 14 patients or 32%; CT in 42 patients or 95.4%; MRI in 5 patients or 11.3%. The good visualization aspect of the disco-corporal tray makes CT a most commonly used examination, as is the case in our series and as demonstrated in the literature [18]. The existence of neurological signs without radiographic and CT scan lesions make it necessary to carry out a magnetic resonance imaging. Difficult to carry out in our environment due to inaccessibility and cost, MRI detects

lesions even of simple spinal cord contusions.

The cervical spine is the spinal segment most concerned by child trauma with 60-80% of cases [10]. Most paediatric cervical lesions occur between the base of the skull and the 4th vertebra (especially in children under 8 years of age). This predominance of cervical spine injury is explained by the biomechanics of the child's spine.

In addition to the large head and weak neck muscles, the pediatric spine is also more mobile due to the shallow depth of the occipital condyles, the horizontal orientation of the facet joints (30° as opposed to 60°-70° in adults), the small incus, increased elasticity of the posterior joint capsules, and a cartilaginous junction between the vertebral bodies and their growth plates. The transverse movements (extension/flexion) and mobility of the child's cervical spine are increased compared to the adult's cervical spine. The cranio-cervical junction and the upper cervical vertebrae are very vulnerable to sudden accelerations and decelerations due to trauma. Most pediatric spinal trauma occurs most often in the cervical spine (80%) [18].

In our series, we noted the predominance of cervical spine injuries, with 27 cases (61.3%), and this according to the age group from 1 to 9 years old, with 12 cases (27.3%).

Table 5 shows the types of lesions encountered compared to those in another series.

It is often rare for a child's spinal trauma to be isolated. They most often occur in a context of polytrauma of 20 to 60% [17], and may be associated with other lesions, especially cranioencephalic lesions [1]. These lesions are thought to influence the morbidity and mortality of child victims of spinal trauma [19]. In our series, we noted 3 cases of cranioencephalic trauma and 1 case of trauma to the pelvis, representing 9% of the total number of cases in our series.

The management of spinal trauma begins at the site of the trauma and includes transport, symptomatic medical treatment and the actual management, whether orthopaedic or surgical. Medical management of spinal cord injuries requires resuscitation and antibiotics for all cervical lesions with respiratory problems. In our series, seven patients (16%) received functional treatment, while orthopaedic treatment depends on the type of spinal lesion. The orthopaedic treatment depends on the types of vertebral lesions. In our study only 38.7% received treatment, yet almost all the literature review consulted ([20] 113/137 and [21] 38/40) requires orthopaedic treatment, as in all bone trauma in children. Surgery, which is often a second line of treatment for bone trauma in children, is most often of interest to children in the latter age group. Surgical treatment is determined by the notion of instability which itself results from the fragility of a spinal segment.

This instability can have serious clinical repercussions immediately or later because of the close relationship between the osteo-disco-ligamentary support and its contents, which are the marrow and its roots; but also with subsequent growth. The classical goals of this surgery are reduction, decompression and possibly stabilisation, which are the three classical stages. Obtaining this stabilisation must not compromise mobility and growth, which implies an approach as direct as possible of the spine and a limitation of the sacrifices of the periosteum and disco-ligamentary elements; for the same purpose, the combined and harmonious use of bone grafts and specific osteosynthesis material to avoid any constraining external immobilisation. The anterior approach, hardly practiced in our environment, was done on 8 patients, i.e. 40%, and only concerned the cervical spine, because the posterior approach is the easiest for our practitioners. Physiotherapy is a complementary treatment allowing the resumption of the sensitivomotor and genito-sphincterial functions. All the patients in our series had benefited from it.

Spinal trauma in children is a complex entity, with many complications that can lead to death. Decubitus complications and death are often encountered in the upper cervical regions with spinal cord injuries.

The care being continuous, with real follow-up times, we had the difficulty of taking care of the majority of our patients because they were brought with delay outside of the medical transport. The long-term evaluation of our patients was difficult given the pandemic period at COVID 19.

Table 5. *Comparative distribution of injury types according to authors.*

	Age (year)	Number of employees (n)	Fracture	Fracture-luxation	Luxation	SCIWORA	others
HAMILTON and col. 1992 [7]	0- 9	19	5 (26%)	5 (26%)	1 (5%)	8 (42%)	0
	10-14	36	25 (69%)	5 (14%)	1 (3%)	5 (14%)	0
	15-17	119	67 (56%)	41 (34%)	2 (2%)	9 (8%)	0
	Total	174					
Our series	0-9	15	4 (26,6%)	4 (26,6%)	5 (33%)	2 (18,8%)	0
	10-14	17	2 (11,8%)	6 (35,3)	5 (29,5%)	1 (5,8%)	3 (17,6%)
	15-16	12	6 (50%)	2 (16,6%)	1 (8,4%)	0	3 (25%)
	Total	44					

5. Conclusion

Trauma to the spine in children, like any bone trauma, responds well to orthopaedic treatment. Deaths are often related to upper cervical spine injuries or occur in the context of polytrauma. Follow-up should be carried out over several years to detect possible complications at an early stage. Delays in treatment due to the difficulties of punctual medicalised transport remain the challenge to be met in our environment. It always stays an emergency in children, needing deep examination and fast care must be the first

therapeutic plane in order to prevent spinal cord damage. Thus collaboration between pediatric surgeons, orthopedics surgeons and neurosurgeons is one of important step to reduce the death and coming complications.

References

[1] Diop AA, Hossini A, Kanikomo I, Ka AS, Seye MN. Spinal trauma in children. *AJNS 2006 vol. 25. N°2.*

[2] Ferey S, Kalifa G, Cohen PA, Adamsbaum C. Imaging of pediatric spine injury. *J Radiol 2005; 86: 263-72.*

[3] Hardley MN, Zabramski JM, Browner CM, Rekate H, Sonntag VK. Pediatric spinal trauma: review of 122 cases of spinal cord and vertebral column injury. *Journal of Neurosurgery, 68, 18-24, 1988.*

[4] Parent S, Mac-Thiong JM, Roy-Beaudry M, Sosa JF, Labelle H. Spinal cord injury in the pediatric population: A systematic review of literature. *Journal of neurotrauma 2011; 28: 1515-24.*

[5] Vitale MG, Goss JM, Matsumoto H, Roye DP. Epidemiology of pediatric spinal cord injury in the United States. *Journal pediatrortop 2006; 26: 745-9.*

[6] Bilston LE, Brown J. Pediatric spinal injury: Type and severity are age andmechanism dependent. *Spine 2007; 21: 2339-47.*

[7] Muzumdar D, Ventureyra EC. Spinal cord injuries in children. *Pediatric Neuroscience Journal 2006; 1: 43-8.*

[8] Hamilton MG, Mylks ST. Pediatric spinal injury: review of 174 hospital admissions. *Journal of Neurosurgery. 1992; 77 (5): 700-704.*

[9] Carreon LY, Glassman SD, Campbell MJ. Pediatric spine fractures: Review of 137 hospital admissions. *J Spinal DisordTech. 2004; 17 (6): 477-482*

[10] Bansal ML, Sharawat R, Mahajan R, Dawar H, Mohapatra B, Das K, et al. Spinal injury in Indian children: review of 204 cases. *Global Spine J. 2019. DOI: 10.1177/2192568219887155.*

[11] Turgut M, Akpinar G, Akalan N, Özcan OE. Spinal injuries in the pediatric age group: a review of 82 cases of spinal cord and vertebral columm injuries. *European Spine Journal 5 (3): 148-152.* (1996) *DOI: 10.1007/BF00395505*.

[12] Sane JC, Hope JMV, Souleymane D, Kassé AN, Diouf JD, Nikiema AN et al. (2018) Epidemiology of Traumatic Spinal Injury: A 15-Year. Retrospective Study of 1092 Cases. *Journal of Spine 7: 429. DOI: 10.4172/2165-7939.1000429.*

[13] Katar S, Ozturk P. A, Ozel M, Cevik S, Evran S, Baran O et al (2020). Pediatric Spinal Traumas. *PediatrNeurosurg, 1-6. DOI: 10.1159/000508332.*

[14] Bollini G. Child spine fracture and growth. *Annals of surgery 1990; 44: 189-92.*

[15] Pennecot GF, Chadoutaut F, Pouliquen JC. Severe trauma to the child's spine. *Annals of surgery 35, 506-512, 1981. P 7.*

[16] Saul D, Dresing K. Epidemiology of vertebral fractures in pediatric and adolescent patients. *Pediatr Rep. 2018; 10 (1): 7232.*

[17] Benantar L. Vertebro-medullary traumas in children. Experience of the neurosurgery department (2002-2010) of the Mohamed VI University Hospital in Marrakech. *Thesis Medicine Marrakech, University Cadi AYYAD; 2012, N°36: 113 p.*

[18] 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.*

[19] Viccellio P, Simon H, Pressman BD, Shah MN, Mower WR, Hoffman JR et al A prospective multicenter study of cervical spine injury in children. *Pediatrics. 2001; 108 (2): E20. DOI: 10.1542/peds.108.2.e20.*

[20] Leah Y, Glassman SD, Campbell MJ. Pediatric spine fractures: A review of 137 hospital admissions. *Journal of spinal disord tech 2004; 17: 477-82.*

[21] BavilShakeri M. Spinal Injuries and associated trauma in children. *Surgery journal 2008; 3: 55-7.*