Scientific Research Publishing

Open Journal of Modern Neurosurgery, 2026, 16(1), 83-104
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

Treatment of Spinal Cord Injury of Lower Cervical Spine in Parakou Teaching Hospital of Benin Republic from 2009 to 2019

Kouassi Jean Marie Maurin Kisito Quenum[1*], Comlan Doleagbenou[2], Oumar Coulibaly[3], Bernice Hountondji Quenum[4], Yelian Patrice Houndje[5], Wilfried Dossou[1], Olatoundji Holden Fatigba[1]

[1]Neurosurgery Department of University Hospital, University of Parakou/Chud Ba, Parakou, Benin
[2]Department of Neurosurgery, Lomé University, Lomé, Togo
[3]Neurosurgery Department, UTTB, Bamako, Mali
[4]CPMI-NFED, University of Abomey Calavi, Cotonou, Benin
[5]Anesthesiology Department, University Hospital, Parakou, Benin
Email: *kisitoq@gmail.com

How to cite this paper: Quenum, K.J.M.M.K., Doleagbenou, C., Coulibaly, O., Hountondji Quenum, B., Houndje, Y.P., Dossou, W. and Fatigba, O.H. (2026) Treatment of Spinal Cord Injury of Lower Cervical Spine in Parakou Teaching Hospital of Benin Republic from 2009 to 2019. *Open Journal of Modern Neurosurgery*, **16**, 83-104.
https://doi.org/10.4236/ojmn.2026.161009

Received: November 4, 2025
Accepted: December 28, 2025
Published: December 31, 2025

Abstract

Introduction: Cervical Spine Injuries (CSI) include disc-ligamentous and/or bone lesions of the cervical spine with or without neurological disorders that occur as a result of a wounding action. Emergency care of these patients is correlated to the vital and functional prognosis. **Objectives**: Report our management of spinal cord injury and spine injury due to trauma in the lower cervical spine. **Patients and methods**: This was a cross-sectional, descriptive, analytical study with retrospective and prospective collection of data from January 2009 to June 30, 2019 about 95 patients. Included patients admitted for traumatic spinal cord and spine injuries at lower cervical level with radiology including plain X-ray, CT scan and MRI if necessary. **Results**: The frequency of lower cervical level injury is 50.2% of traumatic spine disorders. The average age of the patients was 33.91 ± 14.51 years and the sex ratio was 11.33. The etiologies are dominated by road traffic accidents (52.25%). The lesions were graded on grade A (38.74%) according to Franckel Scale. Severe sprains were diagnosed in 25.49% of cases. Lesions predominated at C5-C6 levels (33.33%). The surgery was performed in 20 patients. Recovery was effective in 39 patients (41.1%) and death was observed in 16.22% of cases. **Conclusion**: Spinal cord traumatic injury of the lower cervical spine is serious and a real public health problem. Prevention remains the best treatment.

Keywords

Trauma, Cervical Spinal Cord Injury, Cervical Spine, CHUD-B/A

1. Introduction

Cervical spine injuries include disc, ligament or bone injuries to the cervical spine with or without neurological disorders resulting from a traumatic event. They cause serious injuries that are life-threatening or functionally debilitating. They are a major public health problem due to their frequency and severity [1]. The incidence of spinal cord injuries in industrialised countries varies between 18 and 40 cases per year per million inhabitants [2]. The risk of traumatic spinal cord injury in developed countries is estimated to be between 30 and 50 per million per year, representing 10,000 to 15,000 new cases per year in the United States and 1000 to 2000 in France [3]. In 2006, an incidence of 50 spinal injuries per million individuals was reported in Canada [4]. In Senegal, in 2022, a study on the management of cervical spine trauma over a two-year period reported 14 cases treated in one health region [5].

The lower cervical spine is the preferred location for these injuries, making them a nightmare for emergency physicians and neurosurgeons. Cervical spine injuries occur in young adults, predominantly males, with road traffic accidents being the leading cause of spinal cord injury, followed by falls and leisure and sports accidents [6] [7]. The importance of studying cervical spine injuries, particularly those of the lower cervical spine, lies in several factors, including the severity of the often disabling neurological injuries with sensorimotor neurological sequelae and their increasing frequency in young people in our context of the development of two-wheeled means of transport [8]-[10]. Furthermore, surgical treatment is the main indication in the management of patients with spinal cord injury, with the aim, even in the absence of neurological disorders, of correcting anatomical injuries to the lower cervical spine by reducing the displacement of osteoarticular structures, decompressing the spinal cord and stabilising the spine. The time between the injury and surgery determines the chances of recovery [11]-[13]. The lack of data on this pathology is the basis for this study, which aims to evaluate the epidemiological, clinical, radiological, therapeutic and evolutionary aspects of lower cervical spine injuries in our context.

2. Method and Patients

This was a cross-sectional, descriptive, and analytical study. Data collection was retrospective for the period from January 2009 to December 2018 and then from January to June, 2019 (prospective phase).

Inclusion criteria: All patients admitted during the study period for lower cervical spinal cord injury who underwent standard X-ray imaging and cervical CT scan. It concerns lesions from C3 to C7. Of the 114 cases, three were excluded from this study due to incomplete paraclinical data. We used the Franckel scale and the ASIA score to classify lesions identified during clinical examination and the Argenson classification to classify lesions identified on standard X-ray and cervical CT scan. Epidemiological data were used, as well as post-treatment outcomes.

3. Results

3.1. Sociodemographic Data

During the study period, 6,640 patients were admitted to the department. There were 221 cases of spinal cord injury, 111 of which were located in the lower cervical spine, representing 1.67% of admissions and 50.23% of traumatic spinal injuries. The annual trend in lower cervical spinal cord injuries is shown in the following graph (Figure 1).

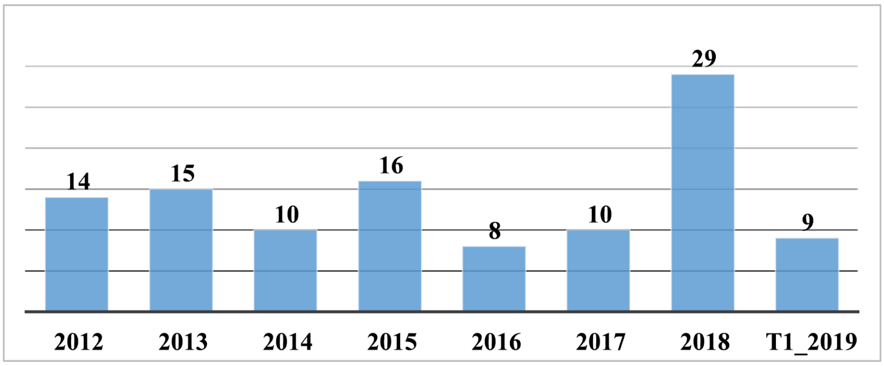

Figure 1. Annual distribution of C3-C7 TVMs (PARAKOU 2019, N = 111).

The study population consisted of 102 (81.9%) men and 9 (8.1%) women, giving a sex ratio of 11.33. The mean age of patients was 33.9 ± 14.5 years, with a median of 30 years and extremes of 4 and 79 years. Among these patients, 32 (28.8%) lived in urban areas and 79 (71.2%) in rural areas. The medical history was dominated by alcoholism in 26 patients (23.4%) and smoking in 15 (13.5%). During this study, 77 (69.4%) patients received medical transport, compared to 34 (30.6%) who were transferred without precautions for cervical spine care, *i.e.*, without a neck brace or maintaining the head-neck-trunk axis. All patients received pain relief upon admission and basic hydration. Neurological deficits were noted in 82 (73.9%) patients and spinal syndrome without neurological deficits in 29 (26.1%).

3.2. Causes of Trauma

The circumstances of the trauma were road traffic accidents (52.3%), workplace accidents (22.5%), and falls (17.1%).

3.3. Clinical Data

Table 1 shows the distribution of patients according to time, reason for admission, and circumstances of the trauma.

The general condition was good in 65 (58.6%) patients and 108 (97.3%) had stable hemodynamics. Three patients were in shock due to multiple trauma. Respiratory status was stable in 96 (86.49%) patients. The data after evaluation of the Franckel scale are shown in Figure 2.

Table 1. Distribution of patients according to time, reason for admission, and circumstances of the trauma (PARAKOU 2019, N = 111).

	Number of patients	(%)
Admission time		
<6 hours	29	26.1
6 - 12 hours	20	18.0
12 - 24 hours	18	16.2
>24 hours	44	39.7
Reason for admission		
Neurological deficit	82	73.9
Neck pain	29	26.1
Genitourinary disorders	4	3.6
Altered consciousness	2	1.8
Loss consciousness	2	1.8
Multiple trauma	2	1.8
Traumatic brain injury	2	1.8
Headache	1	0.9
Circumstances of the trauma		
Traffic road accident	58	52.3
Work accident	25	22.5
Falls	19	17.1
<3 m	1	5.3
3 - 6 m	15	79.0
>6 m	3	15.8
Fight	4	3.6
Assault	3	2.7
Domestic Accident	2	1.8

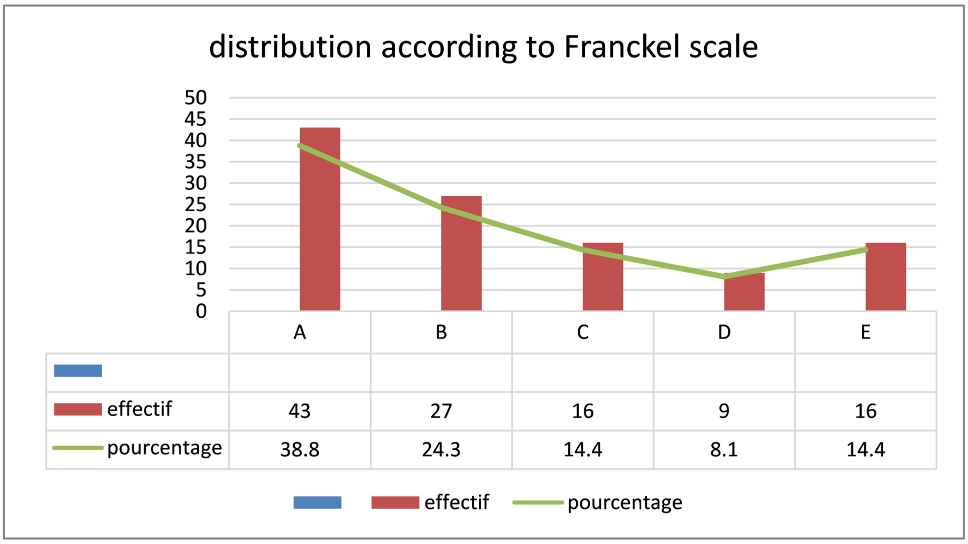

Figure 2. Distribution according to the Franckel scale (PARAKOU 2019, N = 111).

The ASIA score was specified in 62 patients. The ASIA sensory score was between [90 - 112] for 35 (56.45%) patients and the ASIA motor score was less than 30/100 for 27 (45%) patients. The ASIA score assessment data are reported in Table 2.

Table 2. Distribution of patients according to the ASIA scale (PARAKOU 2019, N = 111).

	number	(%)
ASIA sensory (/112) (n = 62)		
10 - 29	5	8.1
30 - 59	13	21.0
60 - 89	9	14.5
90 - 112	35	56.4
ASIA motor (/100) (n = 60)		
0 - 29	27	45.0
30 - 59	12	20.0
60 - 89	6	10.0
90 - 100	15	25.0
MP (/50) (n = 60)		
0 - 24	38	63.3
25 - 50	22	36.7
MT (/50) (n = 60)		
0 - 24	27	45.0
25 - 50	33	55.0

The injuries associated with lower cervical spinal cord trauma in the study were: head injury in 35 (31.53%) patients, including 32 (91.43%, or 32/35) with mild head injury; chest trauma in 3 (2.7%) patients. Two patients had rib fractures and one patient had a pneumothorax. Traumatic injuries to the limbs accounted for 4.5% of patients with fractures.

Standard X-rays were performed on all patients, as well as spinal CT scans. In 9 patients (8.1%), no lesions were detected. Dynamic images were performed in 4 (3.6%) patients 10 days after the traumatic episode. No differences were noted compared to standard images.

3.4. Paraclinical Data

Table 3 shows the different lesions identified by radiographic examination according to the Argenson classification.

Table 3. Distribution of lesions according to standard frontal and lateral radiographs of patients (PARAKOU 2019, N = 102).

	Number of cases	(%)
Anterior displacement	18	17.6
Comminuted fracture	12	11.8
Tear drop fracture	14	13.7
Moderate sprain	16	15.7
Severe sprain	27	26.5
Dislocation biarticular fracture	6	5.9
Uniarticular fracture	2	2.0
Fracture with separation of articular mass	3	2.9
Uniarticular dislocation	4	3.9

Spinal scans were performed on 88 (79.28%) patients. No lesions were detected in 2 (7.14%) cases, and post-traumatic disc herniation was detected in 5 cases (17.9%). The requested MRI could not be performed because it was not available in the healthcare area.

Imaging tests identified the level of injury in 105 (94.59%) patients. See the details in the following **Figure 3**.

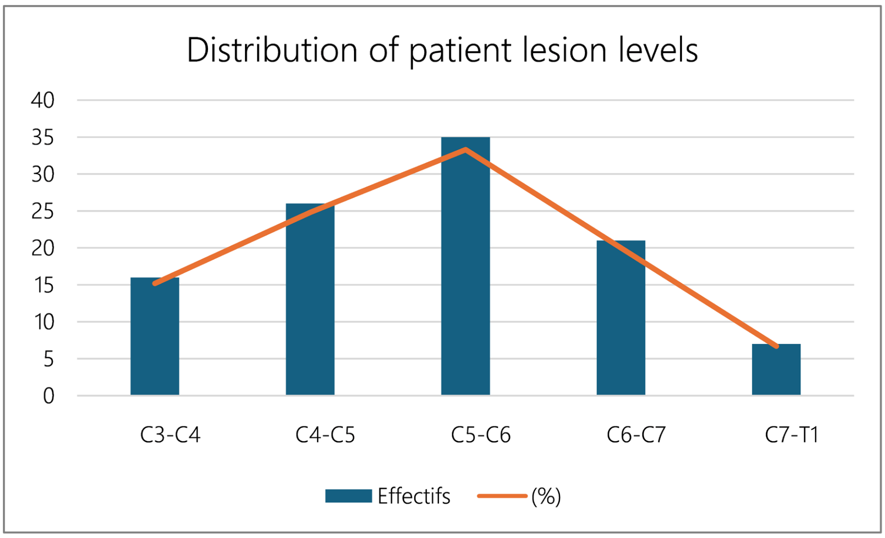

Figure 3. Distribution of injury levels in patients.

3.5. Therapeutic Data

All patients were immobilized, and 110 had received emergency cervical collars (99.1%). Cervical traction using a Gardner stirrup was performed in 3 (2.7%) patients (see illustrations). Surgery was indicated for 76 (68.5%) patients and was performed in 20 (26.3%) of them. Of the 20 patients who underwent surgery, 4 (20%) had health insurance. Of the 56 patients who did not undergo surgery, 12 had clinical respiratory and hemodynamic instability, 7 patients refused surgery, and 37 withdrew due to lack of financial resources. The time to surgery ranged from 1 to 6 days for 12 (60.0%) patients, with a mean time of 10.9 ± 12.8 days and a median of 4.3 days. The surgical treatment data are reported in Table 4.

Table 4. Distribution of patients according to surgical treatment (PARAKOU 2019, N = 111).

	Number	(%)
Completion time (n = 20)		
<1 day (24 hours)	1	5.0
1 - 6 days	12	60.0
7 - 15 days	2	10.0
16 - 20 days	2	10.0
>21 days	3	15.0
Reasons for non-completion (n = 56)		
Lack of financial resources	37	66.1
Parental disagreement	7	12.5
Clinical instability	12	21.4
Indication (n = 20)		
Dislocation	12	60.0
Fracture	5	25.0
Dislocationpproach	3	15.0
Abord (n = 20)		
Anterior approach	18	90.0
Posterior approach	1	5.0
Mixed approach	1	5.0
Procedure (n = 20)		
Dissectomy, iliac graft	4	20.0
Decompressive laminectomy decompressive	1	5.0
Dissectomy, iliac graft, fixation	10	50.0
Arthrectomy, reduction, fixation	1	5.0
Corpectomy, iliac graft, fixation	7	35.0
Osteosynthesis (n = 19)		
Anterior cervical screw plate	19	100.0

3.6. Evolutionary Data

Of all patients, 32 (28.8%) received functional physical therapy. The average time between admission or surgery and the start of therapy was 8.13 ± 7.32 days. Supportive psychotherapy was provided to 12 patients with adjustment disorders related to their neurological state of complete dependence. Of all patients, 64 (57.7%) were clinically stable during the first 7 days. Hyperthermia was observed in 38 patients who presented with neurovegetative disorders.

Among patients who underwent surgery, the condition was stable in 60% (12), while 30% (3) presented with a neurovegetative disorder such as central hyperthermia. Among patients who did not undergo surgery, the condition was stable for 44.6% (25) and 55.4% (31) presented with neurovegetative disorders. Hyperthermia was noted in 44.6% (25) of cases. Figure 4 shows complications in the immediate phase depending on whether or not surgery was performed.

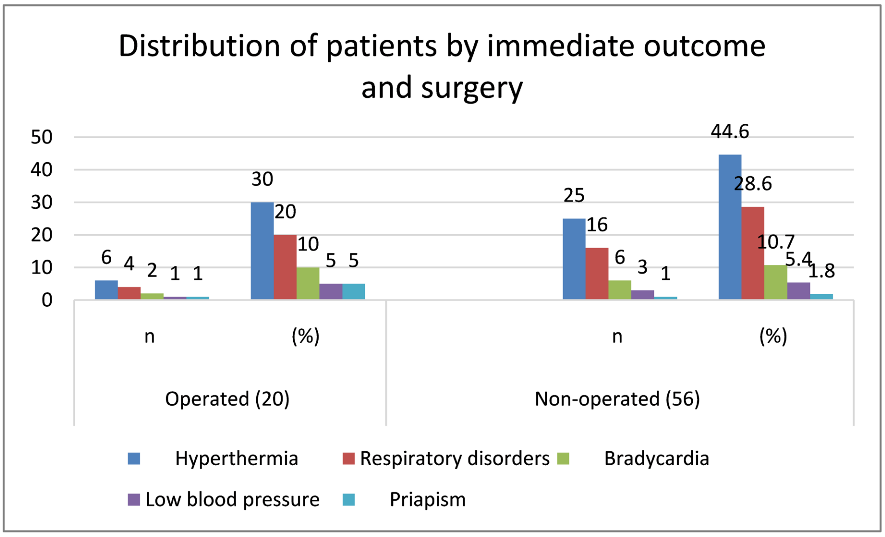

Figure 4. Distribution of patients by immediate outcome and surgery (PARAKOU 2019, n = 76).

In 47 (42.3%) patients, the clinical condition was stable. Neurovegetative disorders were noted in 15 patients.

Recovery was noted in 39 (41.1%) patients. The recovery time ranged from 1 to 47 days, with an average of 12.2 ± 11.9 days. Among the patients who underwent surgery, 70% (14/20) were clinically stable and 12 (60%) of them had recovered within an average of 12.5 ± 12.3 days. Among the patients who did not undergo surgery and for whom surgery had been indicated, 15 (26.8%) were stable and 8 (14.29%) had recovered within an average time of 13.5 ± 15.4 days.

Table 5 shows the recovery time for patients according to the type of treatment.

Table 5. Recovery time according to the type of treatment (PARAKOU 2019, n = 76).

	Operated (20)		Not operated (56)	
	n	(%)	n	(%)
1 - 6 days	5	41.7	4	50.0
7 - 15 days	2	16.7	1	12.5
14 - 20 days	2	16.7	1	12.5
21 - 29 days	2	16.7	1	12.5
>30 days	1	8.2	1	12.5

3.6.1. Postoperative Complications

Neurovegetative disorders were noted in 2 (10%) patients. We noted 2 (10%) cases of parietal suppuration associated with infection of the osteosynthesis material in one case, requiring reoperation. The osteosynthesis material was removed in this case. Neurovegetative disorders were found in 6 (30%) patients and postoperative mortality was 15% (3 deaths).

3.6.2. General Complications

Neurovegetative signs were found in 15 (13.5%) patients.

Pressure ulcer complications were found in 28 (25.2%) patients. Pressure sores were noted in 71.4% (20) of cases. At least one neurological sign persisted in 93 (83.8%) patients at discharge. Signs persisted in 94.6% (51) of non-operated patients and 70% (14) of operated patients.

Psychologically, one patient presented with severe anxiety and serious problems adapting and reintegrating into society and work, requiring psychiatric care (supportive psychotherapy).

There were 18 deaths, including 12 preoperatively (12 patients who did not undergo surgery due to clinical instability) and 3 postoperatively. There were 3 deaths among patients for whom surgery was not indicated. In Table 6, we reported the complications observed in patients according to the type of care provided.

Table 6. Distribution of postoperative complications according to the surgical procedure performed (PARAKOU 2019, n = 76).

	Operated (20)		Not operated (56)	
	n	**(%)**	**n**	**(%)**
Postoperative complications				
Parietal suppuration	2	10.0	--	--
Infection of osteosynthesis material	1	5.0	--	--
Psychiatric disorders	n = 1			
Anxiety	1	100.0	--	--
Pressure Ulcer Complications	$n_1 = 8$		$n_2 = 13$	
Pressure sores	5	62.5	9	69.2
Urinary tract infection	3	37.5	3	23.1
Pulmonary infection	-	-	3	23.1
Thrombophlebitis	-	-	2	15.4
Pulmonary embolism	-	-	2	15.4
Paralytic ileus	1	12.5	3	23.1
Neurovegetative disorders	$n_1 = 2$		$n_2 = 8$	
Respiratory disorders	2	100.0	4	50.0
Hypotension	1	50.0	2	25.0
Bradycardia	2	100.0	1	12.5
Hyperthermia	-	-	6	75.0
Sequelae				
Sensory-motor deficit	12	60.0	39	69.6
Genitourinary disorders	2	10.0	19	33.9
None	6	30.0	3	5.4

3.6.3. Discharge Arrangements

The average length of hospital stay was 25.6 ± 36.6 days, ranging from 1 to 212 days.

There were 18 (16.2%) deaths. The average length of hospital stay for patients who died was 6.1 ± 5.9 days, ranging from 1 to 21 days. The discharge modalities are reported in Table 7.

Table 7. Distribution of patients according to discharge modalities (PARAKOU 2019, N = 111).

	number	(%)
Discharge arrangements		
Exit	56	50.5
Discharge against medical advice	37	33.3
Death	18	16.2
Length of hospital stay (n = 90)		
1 - 6 days	25	27.8
7 - 15 days	21	23.3
14 - 20 days	9	10.0
21 - 29 days	13	14.4
30 - 59 days	14	15.6
>60 days	8	8.9
Length of stay of deceased patients (n = 18)		
1 - 6 days	12	66.7
7 - 15 days	4	22.2
14 - 20 days	2	11.1

3.7. Mortality

3.7.1. Frequency

The overall in-hospital mortality rate during the study was 2.1% (137/6640), including 18 (0.3%) cases of lower cervical spinal cord injury. The mortality rate for patients with lower cervical spinal cord injury was 16.2%.

3.7.2. Circumstances of Death

The details are reported in Table 8.

Table 8. Distribution of patients according to causes of mortality.

	Number	(%)
Respiratory distress	14	77.8
Hyperthermia	9	50.0
Infection	2	11.1
Cardiac disorders	7	38.9
Septic shock	3	16.7

3.7.3. Mortality According to Initial Neurological Status

Table 9 shows the discharge status according to the patients' initial Franckel scale.

Table 9. Distribution of patients according to neurological status and mortality (PARAKOU 2019, N = 111).

Franckel scale	DEATH		EXIT		DAMA**		P Fischer
	n	%	n	%	n	%	
A	14	32.6	14	32.6	15	34.9	0.024
B	2	7.4	15	55.6	10	37.0	
C	2	12.5	9	56.3	5	31.3	
D	-	-	6	66.7	3	33.3	
E	-	-	12	75.0	4	25.0	
TOTAL	18	16.4	56	50.9	36	32.7	

DAMA** = Discharge against medical advice.

3.7.4. Concept of Risk and Mortality

Patients who did not undergo surgery despite being indicated for it had a risk of death of 5.3 (95% CI = [1.2 - 22.6]).

Patients with complete deficit and those with autonomic dysfunction had a risk of death of 4.1 with respective confidence intervals of (95% CI = [1.1 - 14.7]) and (95% CI = [1.1 - 15.4]).

Patients with a Franckel score classified as grade A had a risk of death of 4.5 (95% CI = [1.8 - 25.1]). Patients classified as grade C by Franckel had a risk of 0.751 (95% CI = [0.1 - 1]).

Table 10 shows the risks of death according to whether surgery was performed, neurovegetative disorders, type of deficit, and Franckel score.

Table 10. Risks of death according to whether surgery was performed, neurovegetative disorders, type of deficit, and Franckel score (PARAKOU 2019, n = 74).

		TOTAL	DEATH		OR	$IC_{95\%}$	P Fischer
		N	n	%			
Surgery (n = 44)	Performed	20	3	15.0	15.0	reference	0.029
	Not performed	27	13	48.2	48.2	[1.2 - 22.6]	
Neurovegetative disorders	Present	12	6	50.0		reference	0.048
	Absent	62	12	19.4			
Neurological deficit (n = 62)	Complete	13	7				0.027
	incomplete	49	11	22.5		reference	
	Franckel A	28	14	50.0	4.5	[1.8 - 25.1]	
	Franckel B	17	2	11.8	0.6	[0.1 - 5]	
	Franckel C	11	2	18.2	0.7	[0 - 0.1]	0.001
	Franckel D	6	-				
	Franckel E	12	-				

Significance at the 5% threshold.

3.8. Recovery Factors

3.8.1. Functional Recovery

We observed functional recovery in 39 (41.1%) patients who presented with neurological deficits upon admission.

3.8.2. Recovery and Type of Neurological Deficit

Among patients who recovered, 34 (43.6%) had incomplete neurological deficits on admission and only 5 (29.4%) had complete deficits. Table 11 shows recovery according to the type of deficit.

Table 11. Distribution of recovery according to type of deficit (PARAKOU 2019, n = 95).

Type of deficit	Recovered		Not recovered		P (Chi^2)
	n	%	n	%	
Complete	5	29.4	12	70.6	0.212
Incomplete	34	43.6	44	56.4	

3.8.3. Recovery Based on Trauma Associated with Cervical Injuries

Table 12 shows recovery based on injuries associated with cervical trauma.

Table 12. Distribution of patients based on associated trauma and recovery (PARAKOU 2019, n = 95).

Associated traumatism	Recovered		Not recovered		P (Fischer)
	N	%	N	%	
Traumatic brain injury	16	59.1	11	40.7	**0.333**
Chest trauma	1	50.0	1	50.0	
Traumatism of limbs	1	25.0	3	75.0	

3.8.4. Recovery Depending on Whether Surgery Was Performed

Among patients who underwent surgery, the recovery rate was 70.6%. Among those who did not undergo surgery, the recovery rate was 29.4%.

More details are reported in Table 13 with the level of recovery according to whether surgery was performed.

Table 13. Distribution of recovery levels according to whether surgery was performed (PARAKOU 2019, n = 76).

	Recovered		Not-recovered		P (Chi^2)
	N	(%)	n	(%)	
Surgery					0.000
Performed	12	70.6	5	29.4	
Not performed	8	15.1	45	84.9	
Time to surgery					0.142
<1 day	--	--	1	100.0	
1 - 6 days	7	70.0	3	30.0	
7 - 15 days	2	100.0	--	--	
16 - 20 days	--	--	1	100.0	
>21 days	3	100.0	--	--	

3.8.5. Recovery Based on Franckel Score

In Table 14, we showed the level of recovery according to the Franckel score.

Table 14. Distribution of patients according to recovery and Franckel score in the short term (PARAKOU 2019, n = 95).

FRANCKEL SCALE	Recovered		Not recovered		P Pischer
	n	%	n	%	
D30 (n = 38)					
A	4	50.0	4	50.0	**0.003**
B	3	50.0	3	50.0	
C	10	90.9	1	9.1	
D	7	100.0	-	-	
E	5	83.3	1	16.7	
D90 (n = 15)					
A	2	100.0	--	--	
B	2	100.0	--	--	
C	1	100.0	--	--	
D	3	100.0	--	--	
E	6	85.7	1	14.3	
D180					
B	1	100.0	--	--	
C	-	-	--	--	
D	1	100.0	--	--	
E	6	100.0	--	--	

3.9. Iconography

In this paragraph, we showed a picture of one case of a patient presenting cervical lower spinal cord injury with dislocation in Figure 5.

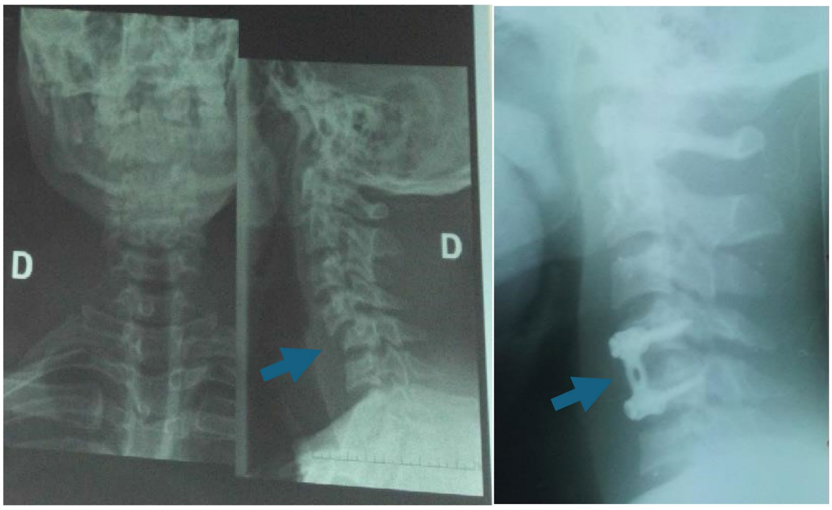

Figure 5. C4-C5 dislocation (standard frontal and lateral X-ray) and post-operative check-up with C4-C5 osteosynthesis by anterior cervical plate.

This is an iconography showing an intraoperative view of intervertebral disc in Figure 6.

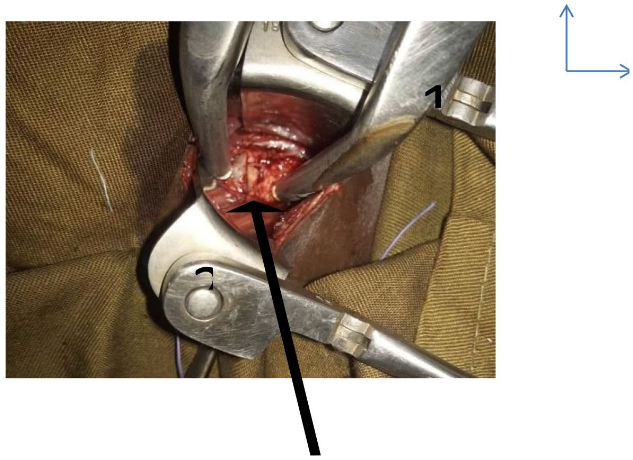

Figure 6. C4-C5 intervertebral disc during surgery under a Caspar and Cloward retractor.

4. Discussion

4.1. Socio-Demographic Data

4.1.1. Frequency of Lower Cervical Spine Injuries Compared to the Spine as a Whole

Cervical spine injuries are the most common type of traumatic spinal injury. The cervical spine is affected in more than 50% of cases, as it is the most mobile part of the entire spine. A study of the frequency of lower cervical spine injuries compared to upper cervical spine injuries shows a clear predominance of lower cervical spine injuries, with a frequency ranging from 60% to 85% [14] [15]. In this series, the study of the frequency of spinal injuries shows a predominance of lower cervical spine injuries, with a frequency of 50.23%.

4.1.2. Frequency According to Age, Gender, and Etiology

As with all trauma pathologies, young adults are most commonly affected [6] [11] [16]. According to certain studies, authors have noted two peaks in frequency: the first between the ages of 17 and 25, and the second between the ages of 36 and 65. This means that the average age is around 35 [17] [18]. In our series, the average age of patients was 33.91 ± 14.51 years, with a median of 30 years and extremes of 4 and 79 years. This result is consistent with those in the literature and shows that young adults are more exposed to accidents of all kinds in their professional and daily activities. Children and adolescents under the age of 20 accounted for only 10.81% of the affected population, probably due to greater ligament laxity [19].

Gender

Most studies published in the literature show a clear male predominance in spinal and spinal cord injuries, with up to 3 - 4 men for every woman. Males were the most represented gender, with a rate of 81.89%, or a sex ratio of 11.3. This result is consistent with data in the literature indicating that males are more affected by cervical spine trauma [6] [8] [20] [21]. This could be explained by the fact that men are more exposed to accidents of all kinds, but also by the extreme caution of females in the face of danger.

4.2. Etiologies (Circumstances of Trauma)

Studies of the circumstances surrounding trauma to the lower cervical spine highlight the classic notion found in various publications, namely a clear predominance of road traffic accidents. In this series, the main etiology is road traffic accidents (52.25%). This result is similar to those found in the literature. It can be explained, on the one hand, by the increasingly widespread use of high-speed two-wheeled vehicles by young adults without helmets and without knowledge of traffic regulations and, on the other hand, by the exponential growth in the number of cars on the road [10] [18] [22]. The cause of these injuries is falls. This difference may be related to the socio-professional characteristics of the populations studied [23] [24].

4.3. Clinical Data

4.3.1. Clinical Examination of the Spine

All studies report the existence of spinal syndrome. In our series, all patients presented with cervical spinal syndrome dominated by spontaneous or provoked neck pain (90.99%). The presence of spinal syndrome is a diagnostic presumption. It should be noted that its absence does not rule out the diagnosis of cervical injury. Hence, the importance of considering it in cases of high-energy trauma, multiple trauma, or minor trauma in the very young or very old, even in the absence of cervical warning signs.

4.3.2. Neurological Examination

In practice, as in the Anglo-Saxon literature, we used the Franckel scale to perform the clinical assessment of our patients. The examination seeks to determine whether the injury is complete or incomplete, the type of deficit, and its predominance.

Neurological signs were observed in 95 patients, or 85.59% of cases, with various neurological disorders. The high frequency of severe sprains and dislocations in certain series, as well as in this study, would explain these results. The injuries were also classified according to grade A (38.74%) on the Franckel scale. These results are similar to those in the literature [3] [7] [18].

4.3.3. Associated Injuries

In this study, traumatic brain injury was the most common injury associated with lower cervical spine trauma (31.53%). Limb injuries were detected in 5 (4.5%) patients and chest injuries in 3 (2.7%) patients. According to some authors, associated injuries included head injuries, facial injuries, chest injuries, and limb fractures. Analysis of the results of this series and the literature shows that head injury is the most common injury associated with cervical spinal cord injury [21] [24]. This injury assessment is consistent with the dogma that "any patient with severe head trauma should be considered to have spinal trauma until proven otherwise".

4.4. Paraclinical Aspects

Standard X-rays and helical Computed Tomography (CT) are the two first-line examinations.

4.4.1. Standard Cervical Spine X-Rays

The sensitivity of standard X-rays in detecting spinal injuries varies. However, standard X-rays fail to detect half of all fractures, half of which are unstable [25].

The examination was performed from the front and side. Left or right 3/4 views were not systematically performed. It did not reveal any lesions in 9 cases (8.1%) even though these patients had neurological signs. This result highlights the limitations of standard X-rays in detecting spinal cord injuries.

4.4.2. Dynamic Images

The diagnosis of ligament instability depends on dynamic images taken in flexion or extension, after static images have been taken by an experienced physician. The maneuvers, ideally guided by a specialist, must be interrupted in the event of pain or the appearance of neurological signs. Although these maneuvers are not recommended in the early stages, they remain essential at a later stage when the load is removed. In this series, dynamic radiography was performed on four patients after a 10-day interval following the traumatic episode. However, these examinations did not show any significant difference compared to standard images [14] [15]. This was due to the absence of a cervical CT scan, which was not functional.

4.4.3. Cervical Computed Tomography

Performing a CT scan of the cervical spine is now easy in many healthcare facilities, such as ours. Thin-slice acquisition of the entire cervical spine is rapid, and computer processing of the data allows coronal and sagittal reconstructions to be made from the native slices. It offers maximum sensitivity and specificity for the diagnosis of fractures or dislocations. In this study, CT scans were performed in 28 (25.23%) patients. Lack of financial resources was the reason why it was not performed in most of our patients. Furthermore, when the lesion was clearly visible on a standard cervical X-ray, this allowed us to develop a treatment strategy.

4.4.4. Cervical MRI

Although it is essential for diagnosing spinal cord injuries and in cases of radiological-clinical discordance [26], it is not part of the standard examinations in our context because it is difficult to access, not only due to its unavailability but also its very high cost. None of the patients in this series underwent the requested MRI. This finding is consistent with that of certain authors who also did not note any patients who underwent MRI [18].

4.4.5. Diagnostic Concordance

The cervical spine CT scan confirmed the presence of lesions found on X-ray in all cases. In three patients whose X-rays had not revealed any lesions, the CT scan noted lesions. The CT scan and standard X-rays did not reveal any lesions in two patients in the study who had neurological deficits. This demonstrates the limitations of X-rays and CT scans in detecting spinal cord lesions and the value of MRI, especially in disc and ligament lesions [26].

4.5. Discussion of Radiological Findings

In this series, the C5-C6 joint was the most affected in 33.3% of cases, followed by the C4-C5 joint in 26 (24.8%) cases and the C6-C7 joint in 21 (20%) cases.

In this series, flexion-extension and compression lesions were the most common, accounting for 48.2% and 44.1% of cases, respectively. This finding is consistent with several other series that reported similar frequencies [23] [24].

4.6. Surgical Treatment

In the literature, surgical treatment appears to give better results than orthopedic treatment, especially in cases of cervical spine instability. In this series, surgical treatment was indicated in 76 (68.5%) patients but was only performed in 20 of them. Of these patients, 37 withdrew due to lack of financial resources and 12 did not undergo surgery due to their unstable hemodynamic status. Numerous animal studies have shown the benefits of early relief of spinal cord compression in humans as well [17] [27].

There is no consensus in the literature on the definition of an early surgical delay. Indeed, there is considerable heterogeneity between studies in terms of the concept of delay. In a review of the literature, this "early period" varies between 8 hours and several weeks. In the most recent studies, it ranges from 8 to 72 hours [18] [22] [24] [27]. French recommendations emphasize that an incomplete or rapidly evolving deficit is a surgical emergency and must be treated with decompression, followed by spinal stabilization within 6 to 8 hours of the trauma.

In this series, the average time to surgery was 10.9 ± 12.8 days, with a median of 4.3 days. Only one patient underwent surgery within 24 hours of the trauma. This result contrasts with the data in the surgical literature. As the majority of our patients were referred, the delay in consultation and referral would explain this difference with the data in the literature, while the low socioeconomic status and difficulties in accessing care also contribute to this long delay.

With regard to the approach, in our study, of the 20 surgical procedures for lower cervical spine trauma, 18 were performed via an anterior approach, *i.e.*, 90%, as in several studies in the literature. The posterior approach was used in only one case (5%). In this series, the almost systematic choice of the anterior approach always involved the placement of an interbody graft with anterior cervical plate fixation. In 19 patients who underwent surgery, an autologous iliac interbody graft was used with an anterior cervical plate.

4.7. Rehabilitation

Of all the patients in this series, 32 (28.83%) underwent functional physiotherapy, with an average interval of 8.13 ± 7.32 days between admission or surgery and the start of treatment, depending on the individual case. Patients who underwent surgery systematically underwent this rehabilitation. Supportive psychotherapy was indicated in one case.

4.8. Progression and Complications

In general, the progression of neurological impairment depended on the severity of the initial injury. All patients who were neurologically intact at admission remained so. Forty-one point zero five percent (39) of patients recovered. The recovery time varied between 1 and 47 days, with an average of 12.16 ± 11.94 days. Recovery depended on whether surgery was performed and on the grade of the lesion according to the Franckel scale, with p = 0.000 and p = 0.003, respectively. Surgery increases the chance of recovery by a factor of 4.5, and this chance increases from 4.7 to 7.6 when moving from Franckel grade B to grade E. This is confirmed by several authors [5] [11] [15] [16] [28].

The overall rate of complications from anterior surgery reported in the literature is approximately 5%, ranging from 2.93% to 6.80% [13] [28]. These complications may involve the approach, the donor site, the osteosynthesis material, or the graft. The postoperative complications identified in this study are parietal suppuration (10%), associated in one case with an infection of the osteosynthesis material which required a return to the operating room for removal of the material. Pressure ulcer complications were found in 40% of patients who underwent surgery, with bedsores in 69.2% of cases. There were 3 (15%) post-operative deaths.

It appears that although surgery leads to good recovery, it is not without complications, sometimes including death [29].

Pressure ulcer complications are common and noted by the authors due to prolonged bed rest caused by the deficit. In this study, 28 (25.2%) patients had pressure ulcer complications. At least one neurological sign persisted in 83.8% of patients at discharge. Psychologically, one patient presented with severe anxiety and depression requiring psychiatric care (supportive psychotherapy). Overall mortality was 16.22%, with 51.11% of deaths occurring within the first 15 days of hospitalization.

These data show that spinal cord injuries continue to be associated with serious neurological and psychological sequelae, as well as high mortality rates. Supportive psychotherapy must be combined with surgical treatment and rehabilitation to ensure successful social and professional reintegration. The average age of patients who died was 37.1 ± 14.3 years, and death was much more closely linked to neurovegetative disorders, particularly cardiorespiratory disorders. The average length of hospital stay for patients who died was 6.1 ± 5.9 days, with extremes of 1 and 21 days. Hence, the challenge is to the management of neurovegetative disorders in the acute phase.

The parameters associated with mortality are:

- Surgery p = 0.000 with a risk of death of 5.3 (95% CI = [1.2 - 22.6]) in the absence of surgery.
- Neurological status p = 0.024 with a risk of death ranging from 4.5 (95% CI = [1.8 - 25.1]) to 0.751 (95% CI = [0.1 - 1]) when changing from Franckel A. to Franckel C. Neurovegetative disorders p = 0.048 with a risk of death of 4.1 (95% CI = [1.1 - 15.4]) in the presence of neurovegetative signs.

5. Limitations

The limitation of this study is the unavailability of MRI for the examination of certain lesions. In addition, the study consisted of two phases, retrospective and prospective, in order to compensate for the lack of postoperative follow-up data for an objective evaluation of patients lost to follow-up in this series, as well as those unable to undergo surgery for financial reasons.

6. Conclusion

Spinal cord injury to the lower cervical spine is a common condition (50.2% of traumatic spinal injuries) at CHUD-B, particularly affecting young males, with the main causes being road traffic accidents, workplace accidents, and falls. Its severity lies in the functional and vital prognosis: high mortality, severe neurological and psychological sequelae. Multidisciplinary care remains essential for this type of patient, combining the skills of the emergency physician, anesthetist, resuscitator, radiologist, neurosurgeon, and physical therapist. Pre-hospital care remains a major challenge in our region due to the lack of qualified emergency teams. Surgical treatment yields good functional results if performed early, accompanied by functional rehabilitation. However, surgery in our region remains reserved for patients with a high socioeconomic status due to its high cost. The introduction of insurance to cover these patients in emergency situations will provide a means of care. And will contribute to reducing financial barriers to emergency surgery. Prevention, therefore, remains the best option for combating the consequences of this condition.

Ethical Considerations

This study was carried out as part of a PhD thesis in medicine, and the research protocol was submitted to the local ethics committee of the University of Parakou for a favourable opinion (REF: 208/2019/CLERB-UP/P/SP/R/SA). This work was carried out in compliance with current ethical standards. The agreement of the authorities at various levels was obtained and the anonymity of the patients was respected.

Conflicts of Interest

The authors have no conflicts of interest to declare.

References

[1] Raesslin, S.G., Hssain, I., Arrière, R.B., Ahler, S.M., Rabold, F.T. and Ottner, J.R. (2008) Prise en charge des traumatismes du rachis en urgence. *Urgences*, **87**, 825-836.

[2] Edouard, A., *et al.* (2004) Prise en charge d'un blessé adulte présentant un trau-matisme vertébro-médullaire. *Annales Françaises d'Anesthésie et de Réanimation*, **23**, 930-945.

[3] Rousseau, M., Pascal-Moussellard, H., Lazennec, J. and Catonné, Y. (2012) Évaluation et orientation thérapeutique devant un traumatisme du rachis cervical. *EMC—Traité de médecine AKOS*, **15**, 1-7. https://doi.org/10.1016/s1634-6939(12)51165-8

[4] Stiell, I.G., Wells, G.A., Vandemheen, K.L., *et al.* (2001) The Canadian C-Spine Rule for Radiography in Alert and Stable Trauma Patients. *JAMA*, **286**, 1841-1848. https://doi.org/10.1001/jama.286.15.1841

[5] Wague, D., Cisse, M., Maguette, G., Donzo, A., Cisse, Y., Faye, M., *et al.* (2022) Surgical Treatment of Cervical Spine Trauma in Rural Area (Low Income Country): Our Experience and Results. *Open Journal of Orthopedics*, **12**, 195-203. https://doi.org/10.4236/ojo.2022.124018

[6] Coleman, W. and Geisler, F.H. (2004) Injury Severity as Primary Predictor of Outcome in Acute Spinal Cord Injury: Retrospective Results from a Large Multicenter Clinical Trial. *The Spine Journal*, **4**, 373-378. https://doi.org/10.1016/j.spinee.2003.12.006

[7] Faure, A., Perroin-Verbe, B., Hamel, O., Khalfallahm, Bord, E., Mathe, F. and Robert, R. (2002) Les traumatismes récents du rachis cervical inférieur. Prise en charge immédiate et démarche clinique. *Rev. Chir. Orthop.*, **88**, 11418.

[8] Ekouele Mbaki, H.B., Boukassa, L., Ngackosso, O.B., Kinata Bambino, S.B., Elombila, M. and Moyikoua, R. (2017) Prise en Charge Hospitalière des Traumatismes du Rachis Cervical à Brazzaville. *Health Sciences and Disease*, **18**, 43-47.

[9] Jackson, A.B., Dijkers, M., DeVivo, M.J. and Poczatek, R.B. (2004) A Demographic Profile of New Traumatic Spinal Cord Injuries: Change and Stability over 30 Years. *Archives of Physical Medicine and Rehabilitation*, **85**, 1740-1748. https://doi.org/10.1016/j.apmr.2004.04.035

[10] Motah, M., Ndoumbe, A., Kuate, C., Tchakounte Youngui, B., Sende Ngonde, C., Djientcheu, V.D.P., Beyiha, G. and Mouelle Sone, A. (2014) Prise en charge pré-hospitalière des patients victimes de traumatisme vertébro-médullaire en milieu africain. *Health Sciences and Disease*, **15**, 1-6.

[11] Dobran, M., Iacoangeli, M., Nocchi, N., Di Rienzo, A., di Somma, L.G., Nasi, D., *et al.* (2015) Surgical Treatment of Cervical Spine Trauma: Our Experience and Results. *Asian Journal of Neurosurgery*, **10**, 207-211. https://doi.org/10.4103/1793-5482.161192

[12] Shakya, B., Bista, P. and Shrestha, D. (2014) Instrumentation in Cervical Spine Injury: Neurological Outcome Measurement Using ASIA Impairment Scale. *Nepal Medical College Journal*, **16**, 156-160.

[13] Kpelao, E., Diop, A., Beketi, K., Tine, I., Thioub, M., Thiam, A.B., *et al.* (2013) Problématique de la prise en charge des traumatismes graves du rachis cervical en pays sous-développé. *Neurochirurgie*, **59**, 111-114. https://doi.org/10.1016/j.neuchi.2013.04.008

[14] Yadollahi, M., Paydar, S., Ghaem, H., Ghorbani, M., Mousavi, S.M., Taheri Akerdi, A., *et al.* (2016) Epidemiology of Cervical Spine Fractures. *Trauma Monthly*, **21**, 6-10.

https://doi.org/10.5812/traumamon.33608

[15] Passias, P.G., Poorman, G.W., Segreto, F.A., Jalai, C.M., Horn, S.R., Bortz, C.A., *et al.* (2018) Traumatic Fractures of the Cervical Spine: Analysis of Changes in Incidence, Cause, Concurrent Injuries, and Complications among 488,262 Patients from 2005 to 2013. *World Neurosurgery*, **110**, e427-e437. https://doi.org/10.1016/j.wneu.2017.11.011

[16] Hasler, R.M., Exadaktylos, A.K., Bouamra, O., Benneker, L.M., Clancy, M., Sieber, R., *et al.* (2011) Epidemiology and Predictors of Spinal Injury in Adult Major Trauma Patients: European Cohort Study. *European Spine Journal*, **20**, 2174-2180. https://doi.org/10.1007/s00586-011-1866-7

[17] Goldberg, W., Mueller, C., Panacek, E., Tigges, S., Hoffman, J.R. and Mower, W.R. (2001) Distribution and Patterns of Blunt Traumatic Cervical Spine Injury. *Annals of Emergency Medicine*, **38**, 17-21. https://doi.org/10.1067/mem.2001.116150

[18] Babatunde, A.S. (2002) Spinal Cord Injuries in Ilorin, Nigeria. *West Africa Journal of Medicine*, **21**, 230-232.

[19] Lustrin, E.S., Karakas, S.P., Ortiz, A.O., Cinnamon, J., Castillo, M., Vaheesan, K., *et al.* (2003) Pediatric Cervical Spine: Normal Anatomy, Variants, and Trauma. *RadioGraphics*, **23**, 539-560. https://doi.org/10.1148/rg.233025121

[20] Teasell, R.W., Arnold, J.M.O., Krassioukov, A. and Delaney, G.A. (2000) Cardiovascular Consequences of Loss of Supraspinal Control of the Sympathetic Nervous System after Spinal Cord Injury. *Archives of Physical Medicine and Rehabilitation*, **81**, 506-516. https://doi.org/10.1053/mr.2000.3848

[21] Bemora, J.S., Rakotondraibe, W.F., Ramarokoto, M., Ratovondrainy, W. and Andriamamonjy, C. (2017) Aspects épidémiologiques des traumatismes du rachis: À propos de 189 cas. *Pan African Medical Journal*, **26**, Article 16. https://doi.org/10.11604/pamj.2017.26.16.11350

[22] Kawu, K., Adebule, G.T., Gbadegesin, A.A., Alimi, M.F. and Salami, A.O. (2010) Outcome of Conservative Treatment of Spinal Cord Injuries in Lagos, Nigeria. *Nigerian Journal of Orthopaedics and Trauma*, **9**, 21-23. https://doi.org/10.4314/njotra.v9i1.54725

[23] Hoffman, J.R., Mower, W.R., Wolfson, A.B., Todd, K.H. and Zucker, M.I. (2000) Validity of a Set of Clinical Criteria to Rule Out Injury to the Cervical Spine in Patients with Blunt Trauma. *New England Journal of Medicine*, **343**, 94-99. https://doi.org/10.1056/nejm200007133430203

[24] Dahlan, R.H., Ompusunggu, S.E., Baselim, I.M. and G., Y.R.B. (2019) Cervical Spine Trauma. *Asian Australasian Neuro and Health Science Journal* (*AANHS-J*), **1**, 19. https://doi.org/10.32734/aanhs-j.v1i2.1042

[25] Blackmore, C.C. (2005) Clinical Prediction Rules in Trauma Imaging: Who, How, and Why? *Radiology*, **235**, 371-374. https://doi.org/10.1148/radiol.2352040307

[26] Dai, L. (2001) Magnetic Resonance Imaging of Acute Central Cord Syndrome: Correlation with Prognosis. *Chinese Medical Sciences Journal*, **16**, 107-110.

[27] Fehlings, M.G. and Perrin, R.G. (2005) The Role and Timing of Early Decompression for Cervical Spinal Cord Injury: Update with a Review of Recent Clinical Evidence. *Injury*, **36**, S13-S26. https://doi.org/10.1016/j.injury.2005.06.011

[28] Ibrahima, B., Seylan, D., Kéren, A.H.S., Boubacar, B.A., Mohamed, C., Aboubacar, C.M., *et al.* (2025) Cervical Spine Trauma: A Retrospective Study of 121 Cases. *Open Journal of Modern Neurosurgery*, **15**, 224-231. https://doi.org/10.4236/ojmn.2025.153024

[29] Winslow, C. and Rozovsky, J. (2003) Effect of Spinal Cord Injury on the Respiratory System. *American Journal of Physical Medicine & Rehabilitation*, **82**, 803-814. https://doi.org/10.1097/01.phm.0000078184.08835.01