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Surgical Outcomes of Spinal Trauma Management in a Resource-Limited Country

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Abstract

Introduction: Spinal Cord Injuries (SCIs) constitute a major cause of long-term disability in low-resource settings. In these contexts, surgical management remains particularly challenging due to delayed presentation, limited technical resources, and organizational constraints. **Objective:** To evaluate the surgical management and outcomes of spinal cord injuries in a low-resource country. **Methods:** We conducted a retrospective descriptive and analytical study, from January 1, 2019, to December 31, 2023. All patients admitted for spinal trauma were included. Epidemiological, clinical, radiological, therapeutic, and outcome variables were analyzed. Data management and statistical analyses were performed using Epi Data version 3.1 (2007) and Microsoft Excel 2021. **Results:** A total of 67 patients underwent surgical intervention. The mean age was 40.9 ± 14.3 years, with a marked male predominance. Road traffic accidents were the leading etiology, accounting for 65.9% of cases. Cervical spine injuries were the most frequent (67.1%), and 37.8% of patients presented with complete neurological impairment (ASIA grade A). The mean time to surgical intervention was 49 days. Postoperative neurological improvement was observed in 26.9% of patients, while the overall mortality rate was 4.5%. Multivariate analysis demonstrated a significant association between ASIA grade A and the occurrence of postoperative complications (odds ratio ≈ 8.7; p = 0.008). **Conclusion:** Despite prolonged surgical delays, surgery provides acceptable outcomes in terms of spinal stabilization. Improving the organization of the emergency care pathway for spinal trauma should be considered a critical priority to improve neurological and functional outcomes in low-resource settings.

Keywords

ASIA, Benin, Spine Surgery, Spinal Cord Injury

1. Introduction

At the global level, Spinal Cord Injuries (SCIs) represent a major public health challenge because of their profound neurological, functional, and socioeconomic consequences. Their incidence remains high worldwide, with marked regional disparities related to injury mechanisms, health system organization, and access to specialized care facilities [1]. In Low- and Middle-Income Countries (LMICs), particularly in sub-Saharan Africa, SCIs predominantly affect young, economically active individuals, resulting in long-term disability and a substantial socioeconomic burden [1]-[3]. Rapid urbanization and the continuous expansion of motor vehicle fleets have increased the frequency of high-energy trauma, with Road Traffic Accidents (RTAs) constituting the leading etiology of SCIs in most regional series [3] [4].

The predominance of cervical spine injuries in these settings is explained by the biomechanics of road traffic trauma and the intrinsic vulnerability of the cervical spine, a highly mobile and relatively unprotected segment [4]. The management of SCIs constitutes a medical and surgical emergency. The primary injury occurs at the time of the initial impact, whereas secondary injury mechanisms—including ischemia, edema, and inflammation—evolve over subsequent hours and days and largely determine neurological prognosis [1] [3]. This pathophysiological cascade underpins current therapeutic strategies focused on the prevention of secondary insults, early imaging, timely surgical decompression when indicated, and early spinal stabilization [5] [6].

Over the past decade, the concept of *"time is spine"* has gained widespread acceptance, demonstrating that early surgical decompression (≤24 hours) is associated with improved neurological recovery, particularly in cervical spinal cord injuries. Accordingly, updated AO Spine/Praxis guidelines and recommendations from the WFNS Spine Committee advocate for early surgery whenever feasible, combined with optimized hemodynamic management [6]-[8]. However, in resource-limited settings, implementation of these recommendations is hampered by multiple constraints, including inadequate prehospital care, delays in hospital admission, limited access to advanced imaging, financial barriers, and restricted availability of trained personnel, operating theaters, and spinal instrumentation [2] [3]. Consequently, surgical intervention is frequently delayed, and its objectives often shift from neuroprotection to primarily mechanical goals, namely spinal stabilization.

In Benin, data on the surgical management of SCIs remain scarce. This study aims to analyze the experience of the CNHU-HKM of Cotonou in the surgical management of SCIs over a five-year period, by describing patients' epidemiological and clinical characteristics, therapeutic approaches, outcomes, and prognostic factors, in order to identify context-appropriate strategies for improving care.

2. Patients and Methods

2.1. Study Design and Setting

We conducted a retrospective observational study with descriptive and analytical

components over a five-year period, from January 1, 2019, to December 31, 2023, at the University Neurosurgery Clinic (CUNC) of the Hubert Koutoukou MAGA National Teaching Hospital (CNHU-HKM) in Cotonou, Benin. The CUNC is a tertiary referral center in southern Benin, a low-resource country in West Africa, providing neurosurgical care for both adult and pediatric populations.

2.2. Participants

All consecutive patients admitted for spinal trauma during the study period were eligible for inclusion, regardless of age or sex. Patients who died at admission or whose medical records were incomplete or unavailable were excluded. Patients with non-traumatic spinal pathologies were not included in the analysis.

2.3. Clinical Pathway and Definition of Spinal Trauma

Patients with suspected spinal trauma were initially managed in the emergency department of the CNHU-HKM, where resuscitation and initial imaging were performed prior to referral to the CUNC. Spinal trauma was defined as any traumatic injury involving the osseous, discal, or ligamentous components of the spine, with potential involvement of the spinal cord and/or nerve roots, with or without associated neurological deficits, and confirmed by spinal imaging (plain radiography, computed tomography, or magnetic resonance imaging). The neurosurgery unit is equipped with a C-arm fluoroscopy system and surgical instrumentation for spinal stabilization procedures.

2.4. Variables and Outcome Measures

Collected variables included demographic characteristics, clinical presentation, neurological status, imaging findings, surgical management, postoperative complications, and clinical outcomes. Neurological severity was assessed using the American Spinal Injury Association (ASIA) Impairment Scale [9]. This standardized scale evaluates motor and sensory function (light touch and pinprick) across key dermatomes and myotomes from C2 to S5, enabling classification of injuries as complete or incomplete (grades A - E), determination of the neurological level of injury, and prognostic assessment.

2.5. Data Sources and Measurement

Data were extracted from emergency department registers, hospitalization records, operative reports, and individual patient medical files using a standardized data collection form to ensure consistency and completeness.

2.6. Statistical Analysis

Data entry, processing, and statistical analyses were performed using Epi Data version 3.1 (2007) and Microsoft Excel 2021. Descriptive statistics were used to summarize the data, with continuous variables reported as means and standard deviations or medians as appropriate, and categorical variables reported as fre-

quencies and percentages. Measures of central tendency and dispersion were used to describe the study population. A multivariate regression was performed to compare the rate of progressive complications according to ASIA score and the injured spinal segment.

3. Results

During the study period, 526 patients were admitted to the neurosurgery clinic for spinal disorders. Among them, 152 were managed for spinal trauma, corresponding to an annual hospital frequency of 28.9% and an estimated annual incidence of 30.4 cases. Eighty-two patient records met the inclusion criteria, of whom 65 patients underwent surgical treatment. Fifteen patients had not undergone surgery, primarily for financial reasons.

3.1. General Characteristics of the Study Population

Of the 82 patients admitted for spinal trauma, 70 (85.4%) were male, yielding a male-to-female ratio of 5.8. The mean age was 40.9 ± 14.3 years (range: 14 - 75 years). Road Traffic Accidents (RTAs) were the most common mechanism of injury, accounting for 65.9% of cases. The distribution of injury mechanisms is summarized in Table 1. Time from injury to hospital admission was less than 24 hours in 29 patients (35.4%), whereas 28 patients (34.1%) were admitted more than one week after injury; 13 patients (15.9%) were admitted within 6 hours. Transfer to the hospital was performed by non-medical transport in 50 cases (60.9%).

3.2. Clinical and Imaging Findings

At admission, cervical spine injuries were predominant, accounting for 47.6% of cases (39 patients), followed by thoracic spine injuries in 19.5% (16 patients). Motor deficits were present in 60 patients (73.1%), with tetraplegia and paraplegia observed in 31.7% and 26.7% of cases, respectively (19 and 16 patients). Sphincter dysfunction was noted in 32 patients (39.0%), respiratory impairment in 38.9%, central hyperthermia in 9.5%, and priapism in 17.6%.

According to the ASIA Impairment Scale, 19 patients (23.2%) were classified as grade A, while 18 patients (22.0%) were classified as grade E. Associated traumatic brain injury and musculoskeletal injuries were present in 17.0% (14 patients) and 12.2% (10 patients), respectively.

All patients underwent plain spinal radiography. Computed tomography and magnetic resonance imaging were performed in 23.2% and 42.7% of cases, respectively. The distribution of vertebro-spinal cord lesions is presented in Table 2.

3.3. Therapeutic (Surgical) Management

Surgical treatment was performed in 65 patients (79.2%). Stabilization osteosynthesis was carried out in 51 patients. For the vast majority of patients (94.0%), surgery was performed more than 72 hours after injury. The mean interval between trauma and surgical intervention was 49 days, with extremes ranging from

less than 1 hour to 120 days. Table 3 summarizes the surgical approaches according to the spinal segment involved.

3.4. Outcomes

Progressive complications related to prolonged immobilization (pressure ulcers, pneumonia, and urinary tract infections) were present in 17 cases (20.7%). Early neurological improvement, as assessed by the ASIA score, was observed in 26.9% of patients. Postoperative complications were mainly surgical site infections in 8 cases (12.3%).

Table 1. Distribution of patients according to the circumstances of injury occurrence.

	N	%
Road traffic accident	54	65.9
Workplace accident	12	14.6
Domestic accident	9	11.0
Falls from a height	3	3.7
Assault	2	2.4
Sports accident	2	2.4
Total	**82**	**100.0**

Table 2. Distribution of patients according to spinal cord lesions on imaging.

	N	%
Spinal body lesions (fractures)	52	74.3
Ligamentous injuries	26	37.14
Disc injuries	24	34.28
Spinal cord lesions	42	60
Prevertebral hematoma	2	2.85

Table 3. Distribution of patients according to the surgical approach.

	N	%
Cervical spine	**45**	**67.16**
Anterior	15	22.39
Posterior	11	16.42
Combined	19	28.35
Thoraco-lumbar spine	**20**	**32.84**
Posterior	19	31.35
Anterolateral	01	1.49
Total	**65**	**100**

The spinal segment involved was not significantly associated with the occurrence of postoperative complications ($p = 0.281$; Table 4). In contrast, patients classified as ASIA grade A had a significantly higher rate of progressive complications ($p =$

0.008; odds ratio ≈ 8.7). The hospital mortality rate in this study was 4.5%.

Table 4. Distribution of the risk of progressive complications according to the injured spinal segment or initial neurological status.

	Total (N)	Complications			p	OR	CI 95% OR
		No	Yes				
		n	n	(%)			
Injured spinal segment					0.281		
Cervicothoracic	1	0	1	(100.0)			
Thoracic	8	5	3	(37.5)		1	
Cervical	42	26	16	(38.1)	0.975	1.1	0.2; 4.9
Thoracolumbar	5	1	4	(80.0)	0.155	6.7	0.5; 91.3
Lumbar	9	4	5	(55.6)	0.459	2.1	0.3; 14.5
Initial neurological status (ASIA)		0			0.053		
ASIA A	19	6	13	(68.4)	**0.008**	**8.7**	1.8; 42.6
ASIA B	9	4	5	(55.6)	0.084	5.0	0.8; 31.0
ASIA C	7	4	3	(42.9)	0.272	3.0	0.4; 21.3
ASIA D	15	10	5	(33.3)	0.413	2.0	0.4; 10.5
ASIA E	15	12	3	(20.0)		1	

Abbreviations: OR, Odds Ratio; CI, Confidence Interval.

4. Discussion

4.1. Study Limitations

The main limitations of this study include its retrospective design, incomplete medical records, and the absence of long-term functional follow-up.

4.2. Key Findings

This study confirms that Spinal Cord Injuries (SCIs) managed at the CNHU-HKM predominantly affect young, economically active adults, with a marked male predominance. These patients are mainly victims of road traffic accidents, with a consistent predominance of cervical spine injuries related to high-energy trauma mechanisms and the biomechanical vulnerability of this spinal segment. This epidemiological profile is comparable to that reported in other African series [1]-[3].

Despite a substantial proportion of surgically treated patients, overall outcomes remain limited by prolonged surgical delays, which are far from current international standards [1]-[6]. Consequently, in our setting, surgical management of SCIs is primarily focused on spinal stabilization rather than neuroprotection.

4.3. Advances in Imaging

This study reports the systematic use of plain spinal radiography regardless of the

spinal segment involved. In addition, access to Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) has increased compared with previous local series [10], allowing more accurate lesion characterization and more rational surgical planning.

4.4. Surgical Delay: A Major Gap from the "Time is Spine" Concept

Acute-phase management of patients with spinal cord injury is complex and highly specialized. Barriers to early surgical decompression include logistical challenges related to transportation from the accident scene, limited access to hospitals and spine-trained surgeons, and constraints in operating room availability and intensive care resources [11]. Additional delays may occur at various diagnostic stages, including initial clinical recognition of spinal cord injury and access to, as well as interpretation of, advanced imaging studies.

The most critical issue highlighted by our data is the mean surgical delay of 49 days. Such timing is incompatible with the neuroprotective objectives of early surgery. The majority of patients present well beyond the optimal therapeutic window for decompression, during which timely intervention could translate into meaningful long-term functional recovery [12] [13]. Current evidence strongly supports the "time is spine" concept, demonstrating that decompression and stabilization within 24 hours are associated with improved neurological outcomes, particularly in cervical injuries [5] [7] [14]-[16]. In our context, the primary challenges are organizational, including progressive reduction of treatment delays, improved access to spinal implants and financial coverage, and enhanced availability of operating rooms and trained personnel.

4.5. Neurological Recovery, Complications, Prognostic Factors, and Mortality

Multivariate analysis identified ASIA grade A as a factor significantly associated with postoperative complications (OR ≈ 9.6), confirming the decisive role of initial neurological status in patient outcomes [7] [8]. Patients with complete neurological injuries typically present with more severe lesions, prolonged immobilization, higher risks of respiratory, urinary, and skin complications, and limited neurological recovery. Prevention of these complications relies on measures recommended by international guidelines for pressure injury prevention and management [17].

Reducing complications related to prolonged immobilization represents an achievable objective even in resource-constrained settings through protocol-based care, staff training, minimum availability of pressure-relieving mattresses, and supervised early mobilization.

The relatively low mortality rate and the moderate neurological improvement observed should be interpreted in light of the absence of long-term follow-up and the prolonged surgical delays, which limit the potential neuroprotective effect of surgical intervention.

5. Conclusions

Spinal cord injuries remain a major public health concern in Benin, predominantly affecting young and economically active individuals. In a resource-limited setting characterized by significant delays to surgical intervention, operative management primarily fulfills a mechanical role by ensuring spinal stabilization, with limited neuroprotective benefit. Although acceptable short-term outcomes were achieved, prolonged surgical delays substantially compromise the potential for neurological recovery.

These findings underscore the urgent need to strengthen the organization of spinal trauma care through the development of a structured and integrated SCI care pathway, improved access to advanced imaging and spinal instrumentation, timely surgical referral, and enhanced multidisciplinary coordination. Addressing these systemic challenges is essential to reduce delays, minimize complications, and ultimately improve neurological and functional outcomes in patients with spinal cord injuries in low-resource settings.

Ethical Considerations

All collected data were anonymized and handled with strict confidentiality in accordance with ethical principles for observational research.

Conflicts of Interest

The authors declare no conflicts of interest related to this study.

References

[1] Kassahun Bekele, B., Boluwatife Samuel, F., Soufan, F., Kravarioti, D., Nazir, A., Ahmad Nakhleh, H., *et al.* (2023) Acute Spinal Cord Injury in Africa: Exploring the Long-Term Outcomes and Future Directions of Acute Spinal Cord Injury—Short Communication. *Annals of Medicine & Surgery*, **85**, 5847-5851. https://doi.org/10.1097/ms9.0000000000001405

[2] Romijn, P., Kussige, P.G.P., van Hooff, M.L., Evaniew, N., van de Meent, H., van Middendorp, J.J., *et al.* (2025) Early versus Late Surgical Decompression in Acute Traumatic Spinal Cord Injury: Does It Impact the Quality of Life? *Spinal Cord*. https://doi.org/10.1038/s41393-025-01165-y

[3] Jesuyajolu, D., Ayantayo, T., Oyesiji, E., Bakare, S., David, S.O., Sule, R., *et al.* (2023) Burden of Traumatic Spinal Cord Injury in Africa: A Scoping Review Protocol. *Journal of Surgical Protocols and Research Methodologies*, **2023**, 1-4. https://doi.org/10.1093/jsprm/snad003

[4] Kim, M., Jeong, W., Jang, S., Park, J.H., Bae, Y. and Lee, S.W. (2025) Spinal Cord Injury Epidemiology and Causes: A Worldwide Analysis with 2050 Projections. *Healthcare*, **13**, Article 2552. https://doi.org/10.3390/healthcare13202552

[5] Fehlings, M.G., Tetreault, L.A., Wilson, J.R., Aarabi, B., Anderson, P., Arnold, P.M., *et al.* (2017) A Clinical Practice Guideline for the Management of Patients with Acute Spinal Cord Injury and Central Cord Syndrome: Recommendations on the Timing (≤ 24 Hours versus > 24 Hours) of Decompressive Surgery. *Global Spine Journal*, **7**, 195S-202S. https://doi.org/10.1177/2192568217706367

[6] Kwon, B.K., Tetreault, L.A., Evaniew, N., Skelly, A.C. and Fehlings, M.G. (2024) AO Spine/praxis Clinical Practice Guidelines for the Management of Acute Spinal Cord Injury: An Introduction to a Focus Issue. *Global Spine Journal*, **14**, 5S-9S. https://doi.org/10.1177/21925682231189928

[7] Fehlings, M.G., Evaniew, N., Kurpad, S.N., Skelly, A.C., Tetreault, L.A. and Kwon, B.K. (2025) The AO Spine/Praxis Spinal Cord Institute Clinical Practice Guidelines for Acute Spinal Cord Injury: Interpretation and Implications for Clinical Practice. *Journal of Neurosurgery*, **42**, 526-529.

[8] Sánchez, J.A.S., Sharif, S., Costa, F., Rangel, J.A.I.R., Anania, C.D. and Zileli, M. (2020) Early Management of Spinal Cord Injury: WFNS Spine Committee Recommendations. *Neurospine*, **17**, 759-784. https://doi.org/10.14245/ns.2040366.183

[9] ICF Case Studies (2026) American Spinal Injury Association (ASIA) Impairment Scale. https://www.icf-casestudies.org/introduction/spinal-cord-injury-sci/american-spinal-injury-association-asia-impairment-scale

[10] Madougou, S., Alihonou, T., Lawson, E., Chigblo, P. and Gbedinhessi, C. (2017) Traitement des traumatismes du rachis cervical dans un pays en développement. *J Afr Chir Orthop Traumatol*, **2**, 8-13.

[11] Ranjbar Hameghavandi, M.H., Khodadoust, E., Hassan Zadeh Tabatabaei, M.S., Farahbakhsh, F., Ghodsi, Z., Rostamkhani, S., *et al.* (2024) Challenges in Traumatic Spinal Cord Injury Care in Developing Countries—A Scoping Review. *Frontiers in Public Health*, **12**, Article 1377513. https://doi.org/10.3389/fpubh.2024.1377513

[12] Ahuja, C.S., Nori, S., Tetreault, L., Wilson, J., Kwon, B., Harrop, J., *et al.* (2017) Traumatic Spinal Cord Injury—Repair and Regeneration. *Neurosurgery*, **80**, S9-S22. https://doi.org/10.1093/neuros/nyw080

[13] Ahuja, C.S., Badhiwala, J.H. and Fehlings, M.G. (2020) "Time Is Spine": The Importance of Early Intervention for Traumatic Spinal Cord Injury. *Spinal Cord*, **58**, 1037-1039. https://doi.org/10.1038/s41393-020-0477-8

[14] Jug, M., Kejžar, N., Vesel, M., Al Mawed, S., Dobravec, M., Herman, S., *et al.* (2015) Neurological Recovery after Traumatic Cervical Spinal Cord Injury Is Superior If Surgical Decompression and Instrumented Fusion Are Performed within 8 Hours versus 8 to 24 Hours after Injury: A Single Center Experience. *Journal of Neurotrauma*, **32**, 1385-1392. https://doi.org/10.1089/neu.2014.3767

[15] Yousefifard, M., Hashemi, B., Forouzanfar, M.M., Khatamian Oskooi, R., Madani Neishaboori, A. and Jalili Khoshnoud, R. (2022) Ultra-Early Spinal Decompression Surgery Can Improve Neurological Outcome of Complete Cervical Spinal Cord Injury: A Systematic Review and Meta-Analysis. *Archives of Academic Emergency Medicine*, **10**, e11.

[16] Picetti, E., Demetriades, A.K., Catena, F., Aarabi, B., Abu-Zidan, F.M., Alves, O.L., *et al.* (2024) Early Management of Adult Traumatic Spinal Cord Injury in Patients with Polytrauma: A Consensus and Clinical Recommendations Jointly Developed by the World Society of Emergency Surgery (WSES) & the European Association of Neurosurgical Societies (EANS). *World Journal of Emergency Surgery*, **19**, Article No. 4. https://doi.org/10.1186/s13017-023-00525-4

[17] Gould, L.J., Alderden, J., Aslam, R., Barbul, A., Bogie, K.M., El Masry, M., *et al.* (2023) WHS Guidelines for the Treatment of Pressure Ulcers—2023 Update. *Wound Repair and Regeneration*, **32**, 6-33. https://doi.org/10.1111/wrr.13130