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Original Research Article

Prediction of complications and death following cervical spine surgery at the National Orthopaedic Hospital, Dala, Kano, Nigeria

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ABSTRACT

Background: Cervical spine surgery is associated with significant morbidity and mortality, particularly in low-resource settings. Identifying predictors of adverse outcomes is essential for preoperative risk stratification and informed patient counselling.
Methods: A retrospective cohort study was conducted on patients who underwent cervical spine surgery for traumatic and degenerative conditions between January 2018 and December 2024 at NOH, Dala Kano. Data extracted included demographics, clinical presentation, neurological status using Frankel grading, comorbidities, injury level, surgical details and postoperative outcomes. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of complications and mortality.
Results: A total of 156 patients (124 males, 32 females) with a mean age of 44.8±14.2 years underwent cervical spine surgery. Major indication was trauma (71.8%). Overall complication rate was 31.4% and mortality rate was 9.6%. The commonest complication was respiratory tract infection (17.3%). The independent predictors of complications were: ASIA grade A injury ($p<0.001$), high cervical injury (C1-C4) ($p=0.002$), associated chest injury ($p=0.008$) and delayed surgery >7 days ($p=0.012$). Independent predictors of mortality were: ASIA grade A injury ($p<0.001$), high cervical injury ($p=0.001$), age >60 years (0.014) and presence of respiratory complications ($p<0.001$).
Conclusions: ASIA A, high cervical level, associated chest trauma, delayed surgery and advanced age are significant predictors of adverse outcomes. These findings highlight the need for early referral, intensive perioperative respiratory support and targeted risk mitigation strategies in high-risk patients.

Keywords: Cervical spine surgery, Complications, Mortality, Predictors, Nigeria, Spinal trauma

INTRODUCTION

Cervical spine surgery encompasses a range of procedures for traumatic, degenerative, neoplastic and infectious conditions affecting the subaxial and upper cervical spine. While surgical intervention aims to achieve neural decompression, restore spinal alignment and provide stable fixation, it is associated with significant morbidity and mortality, particularly in patients with severe neurological deficits and multilevel pathology.[1-2] The cervical spine is the most commonly injured spinal segment in Nigeria, accounting for 55% of all spinal injuries in large multicenter series from the southeast.[3]

Road traffic accidents are the predominant mechanism, affecting young to the middle-aged males disproportionately.[3-4] Despite advances in surgical techniques and perioperative care, mortality rates

following cervical spine injury in Nigerian centres remain high, ranging from 16% to 20% in published series.[3-5]

Complications following cervical spine surgery are diverse and potentially life-threatening. Respiratory complications, including pneumonia and respiratory failure, are particularly common due to diaphragmatic dysfunction in high cervical injuries and prolonged immobilisation.[6] Surgical site infections, implant-related complications, pressure ulcers and thromboembolic events further contribute to morbidity and prolonged hospital stay.[7-8]

Identifying predictors of adverse outcomes is essential for several reasons. First, it enables preoperative risk stratification, allowing surgeons to counsel patients and families about expected outcomes and potential complications. Second, it guides resource allocation, ensuring that high-risk patients receive enhanced perioperative monitoring and support. Third, it informs quality improvement initiatives aimed at reducing modifiable risk factors.[9]

In high-income countries, large database studies have identified numerous predictors of complications and mortality following cervical spine surgery, including advanced age, comorbidities (diabetes, cardiovascular disease), complete neurological injury, high cervical level, and delayed surgical intervention.[10,11] However, these findings may not be directly applicable to Nigerian settings, where patient demographics, disease profiles, healthcare infrastructure and perioperative care protocols differ substantially.

Within Nigeria, several studies have documented complications and outcomes following cervical spine injury and surgery. Uche et al reported a 16% mortality rate in 195 patients with cervical spine injury, with complete injury and high cervical level identified as significant risk factors.[3] Elachi et al found that 63.8% of patients with traumatic cervical spinal cord injury experienced complications, with pressure ulcers and urinary tract infections being most frequent.[5] However, these studies focused predominantly on non-operatively managed patients or mixed cohorts, with limited specific analysis of surgically treated patients.

The national orthopaedic hospital (NOH), Dala, Kano, established in 1959, is one of Nigeria's three specialised orthopaedic tertiary institutions and serves as a major referral centre for northern Nigeria.[12] The hospital has developed significant capacity for cervical spine surgery, performing both anterior and posterior instrumented procedures for trauma and degenerative conditions.[13] However, systematic data on predictors of complications and mortality in this setting are lacking.

This study aims to identify independent predictors of complications and death following cervical spine surgery at NOH, Dala, Kano, over a seven-year period, providing evidence to guide preoperative risk assessment and perioperative care optimisation.

METHODS

This was a retrospective cohort study conducted at the National Orthopaedic Hospital, Dala, Kano, Nigeria. The hospital is a 250-bed federal tertiary institution specialising in musculoskeletal disorders, with a catchment area covering Kano State and neighbouring northern Nigerian states.[12] Data were collected for all patients who underwent cervical spine surgery for traumatic or degenerative conditions between 01 January 2018 and 31 December 2024 (seven-year period). Ethical approval was sought and approved by the Ethical Committee NOH Dala Kano

One hundred and eighty-two patients aged 18 years and above who underwent cervical spine surgery (anterior, posterior, or combined approaches) for traumatic or degenerative conditions were eligible for inclusion. Exclusion criteria were: patients with cervical spine tumours or infections; patients with previous cervical spine surgery; patients with incomplete medical records; and patients lost to follow-up before the minimum 6-month postoperative assessment.

Medical records, operative logbooks, and clinic follow-up notes were reviewed by two independent researchers using a standardised data extraction form. Data collected included:

Demographic characteristics

Age, sex, occupation and comorbidities (hypertension, diabetes mellitus, chronic respiratory disease).

Clinical presentation

Mechanism of injury (for trauma), duration of symptoms, neurological status using Frankel/American spinal injury association (ASIA) Impairment scale, and time from injury to surgery.[14]

Radiological findings

Level(s) of injury/pathology (categorized as high cervical C1-C4 or low cervical C5-C7), number of levels involved, and fracture morphology.

Surgical details

Date of surgery, procedure performed (anterior cervical discectomy and fusion (ACDF), corpectomy, posterior laminectomy with lateral mass screw fixation, combined approach), levels instrumented, operative time and intraoperative blood loss.

Outcome measures

Postoperative complications (respiratory tract infection, surgical site infection, pressure ulcers, implant failure, dural tear, neurological deterioration, thromboembolic events) and mortality (30-day and in-hospital). Cause of death was recorded where available.

Data were entered into Microsoft Excel (Version 16.0) and analysed using SPSS for windows (Version 21.0, IBM Corp., Armonk, NY). Descriptive statistics (frequencies, percentages, means, standard deviations, ranges) were calculated for all variables.

For univariate analysis, categorical variables were compared using Chi-square tests or Fisher's exact test as appropriate, and continuous variables using independent t-tests or Mann-Whitney U tests. Variables with $p<0.10$ on univariate analysis were entered into multivariate logistic regression models to identify independent predictors of complications and mortality.

Adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated. Statistical significance was set at $p<0.05$. Ethical approval was obtained and due to the retrospective nature of the study, the requirement for individual patient consent was waived. Patient confidentiality was maintained through anonymised data collection and secure storage.

RESULTS

A total of 182 patients underwent cervical spine surgery during the study period. After applying inclusion and exclusion criteria, 156 patients were included in the final analysis (26 excluded: 18 with incomplete records, 8 lost to follow-up). Table 1 presents the demographic and clinical characteristics. Mean age was 44.8±14.2 years (range: 18-78 years). There was a strong male predominance (79.5%), consistent with trauma demographics.

Trauma was the predominant indication (71.8%), with road traffic accidents accounting for 86.6% of trauma cases. Complete neurological injury (ASIA A) was present in 30.8% of patients at presentation. High cervical involvement (C1-C4) occurred in 26.9% of patients. Mean time from injury to surgery was 8.6±5.2 days (range: 1-28 days).

Table 2 summarises the surgical procedures and intraoperative parameters. Mean operative time was 198±58 minutes, and mean blood loss was 380±210 ml. Anterior approaches were most common (52.6%), followed by posterior (37.2%) and combined (10.3%). Two-level instrumentation was most frequent (39.7%). Table 3 details complications encountered in the study population.

Overall, 49 patients (31.4%) experienced one or more complications. Respiratory tract infection was the most common complication (17.3%), followed by urinary tract infection (11.5%) and surgical site infection (8.3%). Twelve patients (7.7%) developed respiratory failure requiring mechanical ventilation. Fifteen patients (9.6%) died during the perioperative period or within 30 days of surgery.

Table 1: Demographic and clinical characteristics of 156 patients undergoing cervical spine surgery.

Characteristics	Number (N)	Percentage (%)
Gender		
Male	124	79.5
Female	32	20.5
Age group (years)		
18-30	28	17.9
31-40	42	26.9
41-50	38	24.4
51-60	26	16.7
>60	22	14.1
Indication for surgery		
Trauma	112	71.8
Degenerative	44	28.2
Neurological status (ASIA grade)		
A (complete)	48	30.8
B (sensory only)	32	20.5
C (motor useless)	28	17.9
D (motor useful)	26	16.7
E (normal)	22	14.1
Level of injury/pathology		
High cervical (C1-4)	42	26.9
Low cervical (C5-7)	114	73.1
Comorbidities		
Hypertension	28	17.9
Diabetes mellitus	12	7.7
Chronic respiratory disease	8	5.1
Associated injuries (trauma patients)		
Chest injury	24	21.4
Head injury	18	16.1
Long bone fractures	22	19.6

Causes of death were: respiratory failure (8 patients, 53.3%), sepsis (4 patients, 26.7%), pulmonary embolism (2 patients, 13.3%) and myocardial infarction (1 patient, 6.7%).

All deaths occurred in trauma patients; there were no deaths in the degenerative group. Table 4 presents univariate analysis of factors associated with complications and mortality. On univariate analysis, factors significantly associated with complications were: age >60 years (p=0.012), ASIA grade A injury (p<0.001), high cervical level (p<0.001), associated chest injury (p=0.002), and delayed surgery >7 days (p=0.003). Factors significantly associated with mortality were: age >60 years (p=0.003), ASIA grade A injury (p<0.001), high cervical level (p<0.001) and associated chest injury (p=0.005).

Table 2: Surgical characteristics of 156 patients.

Characteristics	Number (N)	Percentage (%)
Surgical approach		
Anterior (ACDF/corpectomy)	82	52.6
Posterior (laminectomy+fusion)	58	37.2
Combined anterior-posterior	16	10.3
Number of levels instrumented		
1 level	48	30.8
2 levels	62	39.7
≥3 levels	46	29.5
Operative time (h)		
<2	42	26.9
2-4	84	53.8
4	30	19.2
Blood loss (ml)		
<300	68	43.6
300-600	62	39.7
600	26	16.7

Table 3: Complications following cervical spine surgery.

Complications	Number (N)	Percentage (%)
Respiratory complications		
Respiratory tract infection	27	17.3
Respiratory failure requiring ventilation	12	7.7
Infectious complications		
Superficial surgical site infection	9	5.8
Deep surgical site infection	4	2.6
Urinary tract infection	18	11.5
Wound complications		
Pressure ulcers	11	7.1
Wound haematoma	4	2.6
Implant-related complications		
Screw malposition	3	1.9
Implant failure (screw pullout/breakage)	2	1.3
Graft-related complications	2	1.3
Neurological complications		
Transient neurological deterioration	4	2.6
Permanent neurological deterioration	2	1.3
C5 radiculopathy	3	1.9
Dural tear	5	3.2
Thromboembolic complications		
Deep vein thrombosis	4	2.6
Pulmonary embolism	2	1.3
Overall complications	49	31.4

Table 4: Univariate analysis of factors associated with complications and mortality.

Variables	Complications (n=49)	No complications (n=107)	P value	Died (n=15)	Survived (n=141)	P value
Age >60 years	12 (24.5%)	10 (9.3%)	0.012	6 (40.0%)	16 (11.3%)	0.003
Male sex	38 (77.6%)	86 (80.4%)	0.682	12 (80.0%)	112 (79.4%)	0.958
ASIA grade A	28 (57.1%)	20 (18.7%)	<0.001	12 (80.0%)	36 (25.5%)	<0.001
High cervical (C1-4)	22 (44.9%)	20 (18.7%)	<0.001	10 (66.7%)	32 (22.7%)	<0.001
Associated chest injury	14 (28.6%)	10 (9.3%)	0.002	6 (40.0%)	18 (12.8%)	0.005
Delayed surgery >7 days	28 (57.1%)	34 (31.8%)	0.003	8 (53.3%)	54 (38.3%)	0.257
Diabetes mellitus	6 (12.2%)	6 (5.6%)	0.198	2 (13.3%)	10 (7.1%)	0.324
Multilevel surgery (≥3 levels)	18 (36.7%)	28 (26.2%)	0.179	6 (40.0%)	40 (28.4%)	0.346
Operative time >4 h	12 (24.5%)	18 (16.8%)	0.254	4 (26.7%)	26 (18.4%)	0.436
Blood loss >600 ml	10 (20.4%)	16 (15.0%)	0.392	4 (26.7%)	22 (15.6%)	0.273

Table 5: Multivariate analysis of independent predictors of complications and mortality.

Outcome/predictor	Adjusted odds ratio	95% confidence interval	P value
Complications			
ASIA grade A	4.82	2.34-9.91	<0.001
High cervical (C1-4)	3.67	1.89-7.12	0.002
Associated chest injury	3.21	1.56-6.58	0.008
Delayed surgery >7 days	2.84	1.42-5.68	0.012
Age >60 years	2.12	0.98-4.58	0.056
Mortality			
ASIA grade A	6.73	2.41-18.82	<0.001
High cervical (C1-4)	4.95	1.98-12.37	0.001
Respiratory complications	5.28	2.14-13.02	<0.001
Age >60 years	3.42	1.28-9.14	0.014
Associated chest injury	2.86	0.98-8.34	0.054

Table 5 presents multivariate logistic regression analysis of independent predictors of complications and mortality. On multivariate analysis, independent predictors of complications were: ASIA grade A injury (OR 4.82), high cervical level (OR 3.67), associated chest injury (OR 3.21) and delayed surgery >7 days (OR 2.84). Independent predictors of mortality were: ASIA grade A injury (OR 6.73), high cervical level (OR 4.95), respiratory complications (OR 5.28) and age >60 years (OR 3.42).

DISCUSSION

This study identifies independent predictors of complications and mortality following cervical spine surgery at NOH, Dala, Kano, providing the largest analysis of its kind from Northern Nigeria. The findings demonstrate that complete neurological injury, high cervical level, associated chest trauma, delayed surgery, and advanced age are significant risk factors for adverse outcomes, with implications for preoperative risk stratification and perioperative care optimisation.

The overall complication rate of 31.4% in this series is comparable to rates reported in other Nigerian and international studies. Uche et al reported a 16% mortality rate but did not provide detailed complication data for comparison.[3] Elachi et al found that 63.8% of patients with traumatic cervical spinal cord injury experienced complications, though their series included predominantly non-operatively managed patients.[5] The higher complication rate in their study may reflect the inclusion of pressure ulcers and urinary tract infections developing during prolonged conservative management.

Respiratory tract infection was the most common complication (17.3%), consistent with the recognised vulnerability of cervical spinal cord injury patients to pulmonary complications due to diaphragmatic dysfunction, impaired cough and prolonged immobilisation.[6,15] This finding underscores the critical importance of intensive respiratory care, including incentive spirometry, assisted coughing techniques and early mobilisation, in this patient population.[16] Surgical site infection (8.3%) is a concern in our setting, where patients often have prolonged preoperative hospitalisation and suboptimal nutritional status. This rate is higher than the 4-6% reported in some international series but

comparable to other Nigerian reports Urinary tract infection (11.5%) and pressure ulcers (7.1%) reflect the challenges of maintaining optimal nursing care in resource-constrained settings.[5,8,17]

The mortality rate of 9.6% in this surgically treated cohort is lower than the 16% reported by Uche et al in a mixed cohort of operatively and non-operatively managed patients, suggesting that surgical intervention may confer a survival benefit in appropriately selected patients. However, it remains higher than the 5-7% mortality rates reported in high-income countries, reflecting differences in patient presentation, perioperative care infrastructure, and rehabilitation resources.[3,18]

Respiratory failure was the leading cause of death (53.3%), consistent with the pathophysiology of high cervical cord injury and the vulnerability of these patients to pulmonary complications.[6,15] Sepsis (26.7%) and pulmonary embolism (13.3%) were other significant contributors, highlighting the need for rigorous infection control and thromboembolism prophylaxis.[19]

Complete neurological injury (ASIA grade A) was the strongest independent predictor of complications (OR 4.82), consistent with findings from multiple international studies.[10,11,20] Patients with complete injuries have greater physiological derangement, longer immobilisation, and higher susceptibility to secondary complications including respiratory infection and pressure ulcers.[21] High cervical level (C1-4) was associated with a nearly fourfold increased risk of complications (OR 3.67). Injuries at this level affect the phrenic nerve (C3-5), impairing diaphragmatic function and predisposing to respiratory complications.[6] This finding aligns with the Southeast Nigerian series, where high cervical injury was significantly associated with poor outcome.[3] Associated chest injury (OR 3.21) independently predicted complications, reflecting the combined insult to pulmonary function from both the neurological injury and direct thoracic trauma.[22] Patients with cervical spine injury and concomitant chest trauma require particularly intensive respiratory monitoring and support.

Delayed surgery >7 days (OR 2.84) was associated with increased complications, supporting the concept of early surgical intervention in appropriate candidates.[23] While the optimal timing of surgery remains debated, our findings suggest that prolonged delays may increase vulnerability to complications, particularly in resource-limited settings where optimal supportive care during the waiting period may not be available.

Complete neurological injury (OR 6.73) was the dominant predictor of mortality, with 80% of deaths occurring in ASIA A patients. This finding is consistent with the Southeast Nigerian series, where 25 of 32 deaths occurred in patients with complete injury.[3] The pathophysiological basis includes loss of sympathetic tone, cardiovascular instability, and susceptibility to secondary complications.[21]

High cervical level (OR 4.95) independently predicted mortality, reflecting the respiratory compromise inherent in injuries at or above C4.[6] Respiratory complications (OR 5.28) were strongly associated with death, underscoring the need for aggressive respiratory support in high-risk patients.[16]

Age >60 years (OR 3.42) was an independent predictor of mortality, consistent with international literature.[10-11,18] Older patients have reduced physiological reserve, higher comorbidity burden and diminished capacity to recover from complications.[24]

The findings of this study are broadly consistent with the limited Nigerian literature. Uche et al identified complete injury and high cervical level as significant risk factors for poor outcome, with a mortality rate of 16% in their mixed cohort.[3] Our study extends these findings by providing specific analysis of surgically treated patients and identifying additional predictors including associated chest injury and delayed surgery.

The Southeast Nigerian series by Onyia et al on cervical hemilaminectomy for degenerative myelopathy reported mean operative time (2 h 36 min) and blood loss (260 ml) comparable to our degenerative subgroup, with low complication rates.[7] However, their degenerative cohort differs substantially from the predominantly trauma population in our series.

Internationally, the predictors identified in this study align with those reported in large database studies from high-income countries. A National surgical quality improvement program (NSQIP) analysis of 2,304 patients undergoing cervical spine surgery identified ASA class, dependent functional status, and operative time as predictors of complications.[25] The Spine Trauma Study Group reported that ASIA grade, age and associated injuries predicted outcomes following cervical trauma.[26] These findings have several implications for cervical spine surgery practice in Nigeria:

Preoperative risk stratification

The identified predictors enable evidence-based risk assessment, allowing surgeons to counsel patients and families about expected outcomes and potential complications. High-risk patients (ASIA A, high cervical, elderly, chest injury) can be identified preoperatively for enhanced monitoring and support.

Respiratory care intensification

The predominance of respiratory complications as both a complication and cause of death underscores the need for aggressive respiratory protocols, including incentive

spirometry, assisted coughing, early mobilisation and low-threshold ventilatory support in high-risk patients.[16]

Early surgical intervention

The association between delayed surgery and complications supports efforts to expedite surgical treatment in appropriate candidates, though this must be balanced against the need for medical optimisation.[23]

Multidisciplinary care

The complex needs of cervical spine surgery patients, particularly those with complete injuries and high cervical levels, require coordinated multidisciplinary input from neurosurgeons/orthopaedic surgeons, intensivists, respiratory therapists, physiotherapists and nurses.[27]

Infrastructure development

The high complication and mortality rates in this series highlight the need for continued investment in intensive care facilities, respiratory support equipment and specialised nursing capacity in Nigerian tertiary centres.

This study has several limitations. First, its retrospective design introduces potential selection bias and reliance on accurate medical records. Second, the single-centre design limits generalisability to other Nigerian hospitals with different resources and expertise levels. Third, the relatively small sample size for mortality analysis (15 deaths) limits statistical power for detecting some predictors. Fourth, the absence of detailed data on postoperative rehabilitation and long-term functional outcomes limits assessment of full recovery. Fifth, the study spans seven years, during which surgical techniques and perioperative care evolved, potentially introducing temporal bias. Finally, the lack of a standardised protocol for complication definition and reporting may have influenced observed rates.

Prospective multicentre studies with standardised data collection, larger sample sizes and longer follow-up are needed to validate these predictors and identify additional risk factors. Development and validation of a Nigerian-specific risk stratification tool for cervical spine surgery would facilitate clinical decision-making and patient counselling. Research into interventions to mitigate identified risks such as enhanced respiratory protocols, early mobilisation programmes and nutritional support is needed to improve outcomes. Finally, establishing a national spine surgery registry would enable ongoing quality improvement and benchmarking against international standards.

This retrospective cohort study identifies complete neurological injury (ASIA grade A), high cervical level (C1-4), associated chest injury, delayed surgery >7 days, advanced age > 60 years, and respiratory complications as independent predictors of adverse outcomes following cervical spine surgery at NOH, Dala, Kano. The overall complication rate of 31.4% and mortality rate of 9.6% are comparable to other Nigerian series but higher than in high-income countries, reflecting differences in patient presentation, perioperative care infrastructure, and rehabilitation resources. These findings support evidence-based preoperative risk stratification, targeted perioperative care optimisation and continued investment in intensive care capacity for high-risk cervical spine surgery patients in Nigerian tertiary centres.

CONCLUSION

This study demonstrates that complications and death following cervical spine surgery at the National Orthopaedic Hospital Dala, Kano, are significantly influenced by modifiable and non-modifiable risk factors. ASIA A, high cervical level, associated chest trauma, delayed surgery and advanced age are significant predictors of adverse outcomes. These findings highlight the need for early referral, intensive perioperative respiratory support and target risk mitigation strategies in high-risk patients. The strong association between delayed surgery and poor outcomes underscores the urgent need for improved prehospital transport systems, faster access to imaging, and prioritization of surgical resources for patients with complete cervical injuries. Additionally, the high mortality observed in patients with associated chest trauma suggests that multidisciplinary management involving pulmonologists and intensivists should be integrated into the care pathway. While these results are limited by the retrospective, single-centre design and the absence of long-term functional outcome data, they nonetheless provide a strong rationale for developing a locally validated risk stratification tool to guide clinical decision-making. Future prospective studies should evaluate whether early surgical intervention, enhanced respiratory care, and comprehensive rehabilitation protocols can attenuate these predictors and improve overall survival and functional recovery in this vulnerable patient population.

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