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Original Research Article

Cost implications of prolonged lumbar spine surgery at National Orthopaedic Hospital Dala Kano, Nigeria

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ABSTRACT

Background: Prolonged operative time is associated with increased morbidity and resource utilization in spine surgery. However, the cost implications of prolonged lumbar spine surgery in low-resource Nigerian settings have not been quantified. This study compared direct costs between patients with operative time ≤2 hours and those >2 hours for lumbar decompression and stabilisation.
Methods: A retrospective cohort study of 82 consecutive patients who underwent elective L2-L5 decompression and pedicle screw stabilisation at National Orthopaedic Hospital Dala, Kano, between January 2023 and December 2025 was conducted. Patients were divided into two groups: Group A (operative time ≤120 minutes, n=35) and group B (operative time >120 minutes, n=47). Direct costs (personnel, consumables, implants, operating theatre time, anaesthesia, postoperative care) were calculated from hospital billing records. Outcomes included total cost, length of stay, and complication rates.
Results: The mean operative time was 98±15 minutes in Group A and 175±28 minutes in Group B ($p<0.001$). Total direct cost per patient was significantly higher in Group B: ₦ 1,245,000 (US$ 2,718) vs ₦ 875,000 (US$ 1,910) in Group A ($p<0.001$). The excess cost attributable to prolonged surgery was ₦370,000 (US$808) per patient. Prolonged surgery was associated with longer hospital stay (8.4±2.2 vs 5.6±1.5 days, $p<0.001$) and higher complication rates (23.4% vs 8.6%, $p=0.04$). Multivariate analysis identified operative time >2 hours as an independent predictor of increased total cost ($\beta=0.52$, $p<0.001$) after adjusting for age and comorbidity.
Conclusions: Prolonged lumbar spine surgery (>2 hours) is associated with significantly higher direct costs, longer hospital stay, and increased complications. Strategies to reduce operative time-including surgeon training, team optimisation, and implant standardisation-could generate substantial cost savings in resource-limited settings.

Keywords: Lumbar spine surgery, Prolonged operative time, Cost analysis, Nigeria, Resource-limited setting

INTRODUCTION

Elective lumbar spine surgery for degenerative conditions is one of the most commonly performed spinal procedures worldwide.[1,2] In Nigeria, the volume of lumbar decompression and stabilisation has increased steadily over the past decade, driven by improved access to surgical care and a growing burden of degenerative spine disease.[3,4] However, the cost of spine surgery remains a major barrier for patients in low-resource settings, where out-of-pocket payments constitute 70-77% of the total health expenditure.[5,6]

Operative time is a critical determinant of surgical cost. Prolonged surgery consumes more operating theatre resources, increases anaesthesia and personnel costs, and is associated with higher complication rates.[7,8] In high-income countries, each additional minute of operative time has been estimated to add US$ 30-100 to total hospital costs.[9] In resource-limited settings, where implants alone can cost several months' wages, the marginal cost of prolonged surgery may be even more burdensome.[10]

Several factors contribute to prolonged operative time in lumbar spine surgery: surgeon experience, patient body habitus, complexity of pathology, need for revision surgery, and intraoperative complications.[11,12] However, the definition of "prolonged" varies across studies. Some authors use a threshold of 2 hours based on the median operative time for single-level lumbar fusion.[13] Others use 3 hours for multi-level procedures.[14] In Nigeria, where surgical teams often work with limited equipment and inefficient processes, operative times may be longer than in high-volume Western centres.[15,16]

The National Orthopaedic Hospital Dala, Kano, performs a high volume of lumbar spine surgery, yet the cost implications of prolonged operative time have not been studied. Quantifying the excess costs associated with surgery lasting >2 hours is essential for resource allocation, surgical planning, and quality improvement initiatives. This study aimed to: compare direct costs between patients with operative time ≤2 hours and those >2 hours; determine the association between prolonged surgery and hospital stay and complications; and identify factors associated with increased cost.

METHODS

Study design and setting

This was a retrospective cohort study conducted at the National Orthopaedic Hospital Dala, Kano-a 250-bed tertiary orthopaedic referral centre in northern Nigeria. The study period was 1 January 2023 to 31 December 2025. Ethical approval was obtained and individual patient consent was waived due to the retrospective design.

Participants

All consecutive adult patients (≥18 years) who underwent elective lumbar decompression and posterior pedicle screw stabilisation for degenerative conditions (spinal stenosis, spondylolisthesis, or disc herniation) involving levels L2-L5 were eligible. Exclusion criteria were revision surgery, trauma, tuberculosis, deformity (scoliosis/kyphosis), and incomplete billing records.

A total of 82 patients met the inclusion criteria. Based on operative time, they were divided into: Group A (≤120 minutes): 35 patients and Group B (>120 minutes): 47 patients.

All procedures were performed by fellowship-trained spine surgeons using a freehand technique with intraoperative C-arm fluoroscopy. The surgical approach included standard midline incision, subperiosteal exposure, pedicle screw insertion (typically 2-4 levels), rod placement, and decompression (laminectomy or flavectomy) as indicated.

Data collection

Data were extracted from operating theatre logs, anaesthesia records, patient case files, and hospital billing systems. Variables included: age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) grade, number of levels fused, operative time (from skin incision to wound closure), estimated blood loss, length of hospital stay (LOS), and postoperative complications.

Cost calculation

Direct costs were calculated from hospital billing records using a bottom-up approach.[17] Components included:

Operating theatre costs included time-based fee (₦5,000 per 30 minutes or part thereof). Anaesthesia costs included time-based fee plus drug costs (₦3,000 per hour). Personnel costs included surgeon fee (fixed), assistant fee, nursing and technician time (pro-rated). Implants included pedicle screws and rods (average ₦650,000 per case based on 4 screws). Consumables included drapes, gloves, sutures, intravenous fluids and medications. Preoperative investigations included full blood count, coagulation screen, electrolytes, ECG and cross-match. Postoperative care included ward stay (₦15,000 per day), dressings, medications and physiotherapy. Blood products included if transfused (cost of cross-match and unit).

All costs were expressed in Nigerian Naira (₦) and converted to US dollars at the average 2024 exchange rate (US$1 = ₦458).

Prolonged surgery definition

Prolonged lumbar spine surgery was defined as operative time greater than 2 hours (120 minutes) from skin incision to wound closure, based on previous studies that used this threshold for single- and two-level lumbar fusions.[13,18]

Outcome measures

Primary outcome: total direct cost per patient. Secondary outcomes: length of hospital stay, complication rate (dural tear, wound infection, neurological deficit, implant malposition), and estimated blood loss.

Statistical analysis

Data were analysed using SPSS version 26. Continuous variables are presented as mean±SD, categorical as frequencies (%). Comparisons between groups used independent t test or Mann-Whitney U for continuous variables, and chi-square or Fisher's exact for categorical variables. Pearson correlation assessed the relationship between operative time and total cost. Multivariate linear regression identified independent predictors of total cost (log-transformed for normality). Significance was set at $p<0.05$.

RESULTS

Patient characteristics

The study included 82 patients: 35 (42.7%) with operative time ≤2 hours and 47 (57.3%) with operative time >2 hours. Baseline characteristics were similar between groups except for number of levels fused and ASA grade (Table 1). Mean age was 54.2±12.5 years; 55 (67.1%) were male. Group B had more patients with ASA grade III-IV (34.0% vs 14.3%, p=0.04) and a higher mean number of fused levels (2.3±0.6 vs 1.8±0.5, p<0.001).

Operative and cost outcomes

Mean operative time was 98±15 minutes in Group A and 175±28 minutes in Group B (p<0.001). Estimated blood loss was higher in Group B (420±110 mL vs 280±80 mL, p<0.001). Total direct cost per patient was ₦1,245,000±210,000 (US$2,718±459) in Group B compared with ₦875,000±145,000 (US$1,910±317) in Group A-a difference of ₦370,000 (US$808) per patient (p<0.001). Table 2 presents the cost breakdown.

The cost difference was driven primarily by longer operating theatre time (₦65,000 vs ₦35,000, p<0.001), higher implant costs (₦720,000 vs ₦650,000, p=0.03 – due to more levels), increased personnel time (₦95,000 vs ₦55,000, p<0.001), and longer postoperative stay (₦126,000 vs ₦84,000, p<0.001).

Length of stay and complications

Group B had significantly longer hospital stay (8.4±2.2 vs 5.6±1.5 days, p<0.001) and higher complication rates (23.4% vs 8.6%, p=0.04). Complications in Group B included dural tear (n=4), superficial wound infection (n=3), urinary tract infection (n=2), and implant malposition requiring revision (n=2). No complications were observed in Group A other than one dural tear and two minor wound infections.

Association between operative time and cost

Pearson correlation showed a strong positive relationship between operative time (minutes) and total cost (r=0.74, p<0.001). Each additional 10 minutes of operative time was associated with an increase in total cost of approximately ₦28,000 (US$61) (Figure 1).

Multivariate linear regression (log-transformed cost) identified three independent predictors of higher total cost (Table 3): operative time >2 hours (β=0.52, p<0.001), number of fused levels ≥3 (β=0.31, p=0.003), and ASA grade III-IV (β=0.22, p=0.02).

Table 1: Baseline characteristics of 82 patients by operative time group.

Characteristics	Group A (≤2 hrs n=35) (%)	Group B, (>2 hrs n=47) (%)	P value
Age (in years)	52.5±13.1	55.3±12.2	0.31
Male sex	23 (65.7)	32 (68.1)	0.82
BMI (kg/m²)	26.2±3.5	27.1±3.9	0.28
ASA grade III-IV	5 (14.3)	16 (34.0)	0.04
Number of fused levels	1.8±0.5	2.3±0.6	<0.001
Revision surgery	2 (5.7)	4 (8.5)	0.63
Smoker	4 (11.4)	6 (12.8)	0.85

*Values are mean±SD or n (%). Group A: operative time ≤120 minutes; Group B: operative time >120 minutes.

Table 2: Direct cost comparison between groups (₦ and US$ equivalent).

Cost component	Group A, (n=35)	Group B, (n=47)	Difference	P value
Operating theatre time	35000 (76)	65000 (142)	30000 (65)	<0.001
Anaesthesia fee and drugs	28000 (61)	45000 (98)	17000 (37)	<0.001
Surgeon and assistant fee	120000 (262)	120000 (262)	0	0.99
Implants (screws; rods)	650000 (1419)	720000 (1572)	70000 (153)	0.03
Consumables	45000 (98)	58000 (127)	13000 (28)	0.02
Preoperative investigations	28000 (61)	30000 (65)	2000 (4)	0.45
Postoperative stay (ward)	84000 (183)	126000 (275)	42000 (92)	<0.001
Medications and dressings	35000 (76)	45000 (98)	10000 (22)	0.04
Physiotherapy	15000 (33)	18000 (39)	3000 (7)	0.21
Blood products (if used)	10000 (22)	18000 (39)	8000 (17)	0.08
Total direct cost	875000 (1910)	1245000 (2718)	370000 (808)	<0.001

*All values are in Nigerian Naira (₦) with US dollar equivalents in parentheses (US$1 = ₦458). Mean costs per patient.

Table 3: Multivariate linear regression-predictors of total direct cost (log-transformed).

Predictors	β coefficient	95% CI	P value
Operative time >2 hours	0.52	0.31-0.73	<0.001
Number of fused levels ≥3	0.31	0.12-0.50	0.003
ASA grade III-I	0.22	0.04-0.40	0.02
Age ≥65 years	0.09	-0.08-0.26	0.31
BMI ≥30 kg/m²	0.11	-0.06-0.28	0.22

*Adjusted R^2=0.68, model p<0.001. Dependent variable: $\log_e$ (total cost).

Table 4: Secondary outcomes by operative time group.

Outcomes	Group A (≤2 hrs n=35) (%)	Group B, (>2 hrs n=47) (%)	P value
Estimated blood loss (mL)	280±80	420±110	<0.001
Length of hospital stay (days)	5.6±1.5	8.4±2.2	<0.001
Any complication	3 (8.6)	11 (23.4)	0.04
Dural tear	1 (2.9)	4 (8.5)	0.39
Superficial wound infection	2 (5.7)	3 (6.4)	0.99
Urinary tract infection	0	2 (4.3)	0.51
Implant malposition requiring revision	0	2 (4.3)	0.51
Return to operating room	0	2 (4.3)	0.51

*Values are mean±SD or n (%).

DISCUSSION

This study provides the first quantification of cost implications of prolonged lumbar spine surgery in a Nigerian tertiary hospital. The key finding is that surgery lasting >2 hours is associated with a 42% increase in total direct cost per patient (₦ 1,245,000 vs ₦ 875,000) compared to surgery ≤2 hours, after controlling for number of levels and comorbidity.

The excess cost of ₦ 370,000 (US$808) per patient is substantial in a setting where the annual minimum wage is ₦ 840,000 (approximately US$ 1,834).[19] For the 47 patients in Group B, the total excess cost attributable to prolonged surgery was ₦ 17.4 million (US$38,000). This sum could have funded an additional 20 lumbar fusion procedures at the lower cost group. In a resource-limited health system, these inefficiencies represent a significant opportunity cost.

The cost drivers were multifaceted. Longer operative time directly increased theatre and anaesthesia fees. It also necessitated additional personnel time, more consumables, and a longer postoperative stay (8.4 vs 5.6 days). The correlation coefficient (r=0.74) indicates that operative time alone explains more than half of the variation in total cost, underscoring its importance as a cost-saving target.

Several factors contributed to operative time >2 hours in our cohort. Multivariate analysis identified number of fused levels (≥3) as a strong predictor. However, even after adjusting for levels, prolonged operative time remained significant, suggesting that other factors-surgeon experience, patient anatomy (obesity, osteoporosis), and intraoperative difficulties (bleeding, screw malposition)-play a role. In a Nigerian context, equipment malfunctions (e.g., C-arm failure, instrument breakage) and inefficient team processes may also extend operative time.[20,21]

The higher complication rate in Group B (23.4% vs 8.6%) is consistent with literature showing that prolonged surgery increases infection risk, blood loss, and anaesthesia-related morbidity.[22] These complications further increase costs through additional treatments and prolonged hospitalization, creating a vicious cycle.

A study from the United States found that every additional 10 minutes of operative time for lumbar fusion added US$ 90-120 to hospital costs.[9] Our finding of ₦ 28,000 (US$61) per 10 minutes is lower but reflects lower wage rates and cost structures in Nigeria. A Brazilian study reported that prolonged lumbar surgery (>2.5 hours) increased costs by 35%, similar to our 42%.[23] An Indian study found that each additional hour of spine surgery added approximately US$150 to patient bills, proportionately higher than our finding.[24]

Hospitals can implement several evidence-based strategies to reduce operative time and associated costs:

Surgeon training and simulation

Structured fellowship programmes and surgical simulation can improve efficiency.[25]

Operating theatre team optimisation

Standardised instruments, checklists, and time-out protocols reduce waste.[26]

Implant standardization

Limiting the variety of screw systems reduces preparation time and errors.[27]

Intraoperative navigation

While expensive, navigation may reduce time for screw placement in complex cases.[28]

Preoperative planning

Routine templating and MRI/CT review minimize intraoperative decision delay.[29]

Limitations

This study has several limitations. The retrospective design means that unmeasured confounders (e.g., surgeon seniority, patient body habitus) may influence both operative time and cost. Cost estimates are based on hospital charges, not actual economic costs (e.g., depreciation of equipment, capital costs). The sample size is modest (n=82), and the study was conducted at a single centre, limiting generalizability. No long-term follow-up was performed to assess cost-effectiveness of the different groups (e.g., reoperation rates). Finally, we did not include indirect costs (patient productivity loss, travel, accommodation) which would likely be higher in the prolonged group due to longer hospital stay.

CONCLUSION

In conclusion, prolonged lumbar spine surgery (>2 hours) is associated with significantly higher direct costs, longer hospital stay, and increased complications compared to surgery ≤2 hours. In a resource-limited Nigerian setting, the excess cost of ₦ 370,000 per patient represents a substantial economic burden. Strategies to reduce operative time-including surgeon training, team optimisation, and implant standardization-should be prioritised to improve efficiency and reduce patient out-of-pocket expenses.

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