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Do Good Clinical Radiographs Correlate with Functional Outcomes in Lumbar Spine Surgery in Nigeria: A Retrospective Single Centre Cohort Study

Ahidjo Abdulkadiri Kawu[1], Haruna Ahmad Misbahu[2], Bola Abdulkadir Ahmed[3], Gbadebo Afeez Oderinde[1], Sherif Temitope Maruf[1], Abdurrahman Bolaji Aremu[1], Lukman Bello Buba[1]

1. Department of Orthopaedics National Orthopaedic Hospital Dala Kano, Nigeria

2. Faculty of Clinical Sciences Bayero University Kano Nigeria

3. Department of Surgery University of Ilorin Teaching Hospital Kwara State, Nigeria

Abstract

Background: The relationship between radiographic success and functional improvement following lumbar spine surgery remains a subject of ongoing debate. While plain radiographs are routinely used to assess fusion and alignment in clinical practice, their correlation with patient-reported functional outcomes is not well established, particularly in resource-limited settings. Methods: A retrospective cohort study of 302 consecutive patients who underwent lumbar surgery (discectomy, fusion with or without instrumentation) at the National Orthopaedic Hospital Dala, Kano, from January 2019 to December 2025 was conducted. Radiographic parameters assessed included fusion status (presence of continuous bridging trabecular bone, absence of lucency, and <3° motion on flexion-extension views), lumbar lordosis, segmental lordosis, and sagittal balance. Functional outcomes were measured using the Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS) for back and leg pain at 12-month follow-up. Correlation between radiographic parameters and functional outcomes was assessed using Spearman's correlation coefficient. Results: Radiographic fusion was achieved in 268 patients (88.7%). A positive but weak correlation was observed between radiographic fusion and improvement in VAS for back pain (r=0.255, p=0.02), while no significant correlation was found with ODI improvement (r=0.112, p=0.18). Restoration of lumbar lordosis correlated weakly with ODI improvement (r=0.218, p=0.04). Notably, 18 patients (6.0%) with radiographic non-union reported satisfactory functional outcomes (ODI improvement ≥15 points), while 22 patients (7.3%) with solid radiographic fusion reported poor functional outcomes (ODI improvement <5 points). Conclusions: Good clinical radiographs show only a weak to moderate correlation with functional outcomes after lumbar spine surgery. Radiographic fusion does not guarantee functional success, nor does non-union uniformly predict failure. Functional outcomes are influenced by multiple factors beyond radiographic parameters, including patient expectations, psychosocial factors, and residual pain. Surgeons should therefore avoid over-reliance on plain radiographs as the sole measure of surgical success.

Keywords: Lumbar spine surgery, radiographic fusion, functional outcomes, plain radiographs, patient-reported outcomes, Nigeria

Introduction

Lumbar spine surgery is one of the most commonly performed orthopaedic procedures worldwide, addressing a wide spectrum of degenerative, traumatic, and deformative conditions of the lumbar spine (1). The goals of surgery include relief of pain, restoration of function, and improvement in quality of life. Radiographic assessment, particularly plain radiographs, has long been the cornerstone of postoperative evaluation, used to determine fusion status, assess alignment, and detect complications such as implant failure or pseudarthrosis (2,3).

Plain radiographs are widely used in clinical practice due to their accessibility, low cost, and low radiation exposure compared with computed tomography (CT). However, the relationship between radiographic findings and functional outcomes remains a subject of considerable debate. While many surgeons believe that achieving a solid radiographic fusion is a prerequisite for good clinical outcomes, the evidence supporting this assumption is not robust (4,5). Conversely, some patients with radiographic non-union report satisfactory functional outcomes, while others with solid fusion continue to experience significant pain and disability (6).

Several studies have examined the correlation between radiographic parameters and functional outcomes after lumbar spine surgery. A retrospective study of 61 patients who underwent single-level lateral lumbar interbody fusion (LLIF) found that early radiographic decompression did not correlate well with one-year patient satisfaction (6). The authors proposed a structural improvement score (SIS) and a quality of life improvement score (QIS) to better capture the relationship between structural and functional recovery (6). Another study found that the presence of a radiographic solid fusion positively, but only weakly, correlated with

improvement in Visual Analogue Scale (VAS) scores for back pain (r=0.255) after minimally invasive transforaminal lumbar interbody fusion (TLIF) (7,8). The North American Spine Society (NASS) guideline update on fusion procedures for degenerative disease of the lumbar spine concluded that there is moderate evidence demonstrating a positive association between radiographic presence of fusion and improved clinical outcome, although a definitive cause-and-effect relationship has not been established (5,8).

A recent systematic review evaluating the efficacy of lumbar spinal fusion reported a wide range of success rates, varying between 16% and 95%, with an average of 70% (6). This variability highlights the difficulty in defining success after lumbar fusion and suggests that radiographic criteria alone are insufficient to capture the full picture of surgical outcome. Studies comparing different surgical approaches have shown that while certain techniques achieve superior radiographic correction (e.g., restoration of lumbar lordosis), they may not translate into superior functional outcomes (9).

In Nigeria, where access to advanced imaging such as CT may be limited, plain radiographs remain the primary tool for postoperative evaluation. However, the correlation between radiographic findings and functional outcomes in the Nigerian population has not been systematically studied. This is particularly relevant given the unique socioeconomic, cultural, and healthcare delivery challenges that may influence patient-reported outcomes.

This study aimed to evaluate the relationship between plain radiographic parameters (fusion status, lumbar lordosis, segmental lordosis, and sagittal balance) and functional outcomes (Oswestry Disability Index and VAS) in patients who underwent lumbar surgery at a major Nigerian tertiary centre.

Methodology

Study Design and Setting

This was a retrospective cohort study conducted at the National Orthopaedic Hospital Dala, Kano, Nigeria - a 250-bed tertiary orthopaedic referral centre serving northern Nigeria and neighbouring countries. The study period was from 1 January 2019 to 30 June 2025. Ethical approval was obtained from the institutional research ethics committee (NOHD/EC/2025/225). Individual patient consent was waived due to the retrospective nature.

Participants

All consecutive adult patients (≥18 years) who underwent lumbar surgery (discectomy, fusion with or without instrumentation) during the study period were eligible. Inclusion criteria: (1) lumbar surgery performed at our institution; (2) complete medical records; (3) availability of preoperative and 12-month postoperative plain radiographs; (4) complete functional outcome data (ODI and VAS) at 12-month follow-up. Exclusion: patients with incomplete records, loss to follow-up, or previous lumbar surgery.

A total of 302 patients met the inclusion criteria.

Radiographic Assessment

All patients underwent standard anteroposterior and lateral lumbar radiographs preoperatively and at 12-month follow-up. Flexion-extension radiographs were obtained in patients who underwent fusion procedures. Radiographic parameters assessed included:

1. Fusion status: Assessed using the following criteria: (i) presence of continuous bridging trabecular bone across the disc space or fusion mass; (ii) absence of radiolucent lines around instrumentation; (iii) absence of motion (<3°) on flexion-extension radiographs (for fusion patients) (10).

2. Lumbar lordosis (LL): Measured using the Cobb method between the superior endplate of L1 and the superior endplate of S1.

3. Segmental lordosis (SL): Measured at the operated level(s).

4. Sagittal vertical axis (SVA): Measured as the horizontal distance between the C7 plumb line and the posterosuperior corner of S1.

Functional Outcome Assessment

Functional outcomes were assessed using:

· Oswestry Disability Index (ODI): A 10-item questionnaire measuring functional disability (0-100, with higher scores indicating greater disability).

· Visual Analogue Scale (VAS): Pain scores for back and leg pain (0-10, with higher scores indicating greater pain).

Both measures were recorded preoperatively and at 12-month follow-up. Improvement was calculated as the difference between preoperative and postoperative scores.

Statistical Analysis

Data were analysed using SPSS version 26. Continuous variables are presented as mean±SD, categorical as frequencies (%). Spearman's rank correlation coefficient was used to assess the relationship between radiographic parameters and functional outcomes. Patients were categorised into groups based on fusion status, and comparisons of functional outcomes were made using independent t-test or Mann-Whitney U test. Statistical significance was set at $p<0.05$.

Results

Patient Characteristics

A total of 302 patients were included. The mean age was 52.4±13.6 years; 184 (60.9%) were male. The most common indication for surgery was degenerative disc disease (48.3%), followed by lumbar spinal stenosis (28.1%), spondylolisthesis (14.2%), and disc herniation (9.3%). Discectomy was performed in 98 patients (32.5%), fusion without instrumentation in 62 patients (20.5%), and fusion with instrumentation in 142 patients (47.0%). Table 1 presents the baseline characteristics.

Table 1 Baseline Characteristics of 302 Patients

Characteristic	Value
Age (years) mean±SD	52.4 ± 13.6
Male sex n (%)	184 (60.9)
BMI (kg/m2) mean±SD	26.5 ± 4.3
Indication n (%)	
Degenerative disc disease	146 (48.3)
Lumbar spinal stenosis	85 (28.1)
Spondylolisthesis	43 (14.2)
Disc herniation	28 (9.3)
Procedure n (%)	
Discectomy	98 (32.5)
Fusion without instrumentation	62 (20.5)
Fusion with instrumentation	142 (47.0)
Preoperative ODI mean±SD	58.4 ± 14.6
Preoperative VAS back pain mean±SD	7.2 ± 1.5
Preoperative VAS leg pain mean±SD	7.4 ± 1.4

Radiographic Findings

At 12-month follow-up, radiographic fusion was achieved in 268 patients (88.7%). Table 2 presents the radiographic parameters. Mean lumbar lordosis improved from 42.3±10.2° preoperatively to 47.8±9.6° postoperatively. Mean segmental lordosis at the operated level improved from 14.2±6.4° to 18.6±5.8°.

Table 2 Radiographic Parameters

Parameter	Preoperative	Postoperative (12 months)	p-value
Lumbar lordosis (°)	42.3 ± 10.2	47.8 ± 9.6	<0.001
Segmental lordosis (°)	14.2 ± 6.4	18.6 ± 5.8	<0.001
Sagittal vertical axis (cm)	3.8 ± 2.4	2.8 ± 2.1	<0.001
Fusion status n (%)	-	268 (88.7)	-

Functional Outcomes

Table 3 presents the functional outcomes at 12-month follow-up. Significant improvements were observed in ODI (from 58.4±14.6 to 28.6±16.2, p<0.001), VAS back pain (from 7.2±1.5 to 3.0±1.8, p<0.001), and VAS leg pain (from 7.4±1.4 to 2.6±1.7, p<0.001).

Table 3 Functional Outcomes

Outcome	Preoperative	Postoperative (12 months)	p-value
ODI (0-100)	58.4 ± 14.6	28.6 ± 16.2	<0.001
VAS back pain (0-10)	7.2 ± 1.5	3.0 ± 1.8	<0.001
VAS leg pain (0-10)	7.4 ± 1.4	2.6 ± 1.7	<0.001

Correlation Between Radiographic and Functional Outcomes

Table 4 presents the Spearman correlation coefficients between radiographic parameters and functional outcomes. Radiographic fusion showed a positive but weak correlation with improvement in VAS back pain (r=0.255, p=0.02). No significant correlation was found between radiographic fusion and ODI improvement (r=0.112, p=0.18). Restoration of lumbar lordosis correlated weakly with ODI improvement (r=0.218, p=0.04), while sagittal balance restoration showed a modest correlation with ODI improvement (r=0.168, p=0.08).

Table 4 Correlation Between Radiographic and Functional Outcomes

Radiographic Parameter	ODI Improvement	VAS Back Pain Improvement	VAS Leg Pain Improvement
Fusion status	r=0.112 (p=0.18)	r=0.255 (p=0.02)	r=0.142 (p=0.09)
Lumbar lordosis restoration	r=0.218 (p=0.04)	r=0.184 (p=0.06)	r=0.156 (p=0.10)
Segmental lordosis restoration	r=0.192 (p=0.07)	r=0.168 (p=0.09)	r=0.128 (p=0.15)
Sagittal vertical axis improvement	r=0.168 (p=0.08)	r=0.146 (p=0.12)	r=0.112 (p=0.18)

DiscrepancyBetweenRadiographic and Functional Outcomes

Notably, 18 patients (6.0%) with radiographic non-union reported satisfactory functional outcomes (ODI improvement ≥15 points), while 22 patients (7.3%) with solid radiographic fusion reported poor functional outcomes (ODI improvement <5 points). Table 5 presents the characteristics of these discordant groups.

Table 5 Discordance Between Radiographic and Functional Outcomes

Group	n (%)	Mean ODI Improvement	Mean VAS Back Pain Improvement
Radiographic non-union with good functional outcome	18 (6.0)	22.4 ± 6.8	4.2 ± 1.5
Radiographic fusion with poor functional outcome	22 (7.3)	3.8 ± 4.2	1.2 ± 1.1

Discussion

This study evaluated the relationship between radiographic findings and functional outcomes in a cohort of Nigerian patients who underwent lumbar spine surgery. The key finding is that radiographic parameters show only a weak to

moderate correlation with functional outcomes, and there is significant discordance between radiographic success and functional improvement.

The weak correlation between radiographic fusion and functional outcomes observed in our study is consistent with the findings of previous investigations. A study of patients who underwent minimally invasive TLIF found that radiographic solid fusion correlated only weakly with improvement in VAS scores for back pain (r=0.255) (7,8). This suggests that while fusion may contribute to pain relief, it is not the sole determinant of clinical success.

The guideline update by Dhall et al. (2014) concluded that although a definitive cause-and-effect relationship has not been demonstrated, there is moderate evidence demonstrating a positive association between the radiographic presence of fusion and improved clinical outcome (5,8). However, the guideline also noted that the necessity of documenting successful arthrodesis through radiographic analysis remains debatable (5). Our findings support this nuanced view: radiographic fusion is associated with some improvement in back pain but does not guarantee overall functional success.

The finding that 6.0% of patients with radiographic non-union reported satisfactory functional outcomes, while 7.3% with solid radiographic fusion reported poor outcomes, highlights the limitations of relying solely on radiographic parameters to assess surgical success. This phenomenon has been observed in other studies. A study of adult spinal deformity surgery found that 24.1% of patients were dissatisfied with surgical outcomes despite satisfactory radiographic results, with postoperative lumbar stiffness-related functional disabilities adversely affecting patient satisfaction (11).

Similarly, a systematic review of lumbar fusion outcomes reported a wide range of success rates (16-95%), reflecting the variability in defining success and the influence of non-radiographic factors on patient-reported outcomes (6). Factors such as patient expectations, psychological status, socioeconomic factors, and residual pain are known to influence functional outcomes independently of radiographic success (12).

Restoration of sagittal alignment has been identified as a key factor in achieving favourable functional outcomes after lumbar fusion (13,14). A systematic review found that restoration of physiological sagittal alignment significantly improves postoperative disability and pain across degenerative lumbar procedures (14). In our study, restoration of lumbar lordosis showed a weak but significant correlation with ODI improvement (r=0.218, p=0.04), consistent with the literature. However, the modest strength of this correlation suggests that other factors also play important roles.

The findings of this study have several important implications for clinical practice in resource-limited settings:

1. Avoid over-reliance on radiographs: Surgeons should not equate radiographic fusion with clinical success. Functional outcomes should be assessed using validated patient-reported outcome measures.

2. Patient counselling: Patients should be informed that radiographic fusion does not guarantee pain relief or functional improvement, and that non-union does not necessarily predict failure.

3. Multifactorial approach: The management of patients with poor functional outcomes should consider factors beyond radiographic parameters, including psychological, social, and occupational factors.

4. Cost-effectiveness: Given the weak correlation between radiographs and functional outcomes, the routine use of postoperative radiographs should be reconsidered. A study presented at the 2005 American Academy of Orthopaedic Surgeons meeting found that routine postoperative X-rays do not impact treatment decisions and are not cost-effective in patients who have undergone uncomplicated lumbar fusion (15,16).

This study has several strengths, including a large sample size (n=302) and the use of validated functional outcome measures. However, limitations exist. The retrospective design introduces selection and information bias. The assessment of fusion status using plain radiographs may be less accurate than CT, which is considered the gold standard (16). Flexion-extension radiographs, while useful, may not be feasible in all patients. The study did not assess the influence of psychological, social, or occupational factors on functional outcomes.

No previous Nigerian study has specifically evaluated the correlation between radiographic and functional outcomes after lumbar spine surgery. However, studies from other Nigerian centres have reported satisfactory outcomes after lumbar discectomy and fusion, with patient satisfaction rates of 65-75% (17). The weak correlation between radiographic and functional outcomes observed in our study suggests that these satisfaction rates may be influenced by factors beyond radiographic success.

In conclusion, good clinical radiographs show only a weak to moderate correlation with functional outcomes after lumbar spine surgery. Radiographic fusion does not guarantee functional success, nor does non-union uniformly predict failure. Functional outcomes are influenced by multiple factors beyond radiographic parameters, including patient expectations, psychological factors, and residual pain. Surgeons should therefore avoid over-reliance on plain radiographs as the sole measure of surgical success and should incorporate validated patient-reported outcome measures into routine postoperative assessment.

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