

Article

The L5/S1 Adjacent Segment Disease (ASD) Following Lumbar Spine Surgery in a Resource-Constrained Centre in Nigeria

Kawu Ahidjo Abdulkadiri ^{1,*}, Misbahu Haruna Ahmad ², Ahmed Bola Abdulkadir ³, Ramat Ali Mohammad ⁴, Ibrahim Sulyman ⁵, Zailani Buhari ⁶, Obiegbu Henry Obinna ⁷, Jimoh Kabir Ademola ⁸

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, Ilorin, Kwara State, Nigeria

⁴ Department of Surgery, National Orthopaedic Hospital, Azare, Hawul, Borno State, Nigeria

⁵ Department of Surgery, Maitama District Hospital, Abuja, Nigeria

⁶ Department of Surgery, Abubakar Tafawa Balewa University Teaching Hospital, Bauchi, Nigeria

⁷ Department of Surgery, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra State, Nigeria

⁸ Faculty of Clinical Sciences, Osun State University, Oshogbo, Nigeria

*Correspondence: Kawu Ahidjo Abdulkadiri (ahidjokawu@yahoo.com)

Abstract:

Background: Adjacent segment disease (ASD) is a well-recognised long-term complication of lumbar spinal fusion, with the L5/S1 segment being particularly vulnerable when fusion terminates at L5. Data from resource-constrained Nigerian centres on the incidence, features, and outcomes of L5/S1 ASD are scarce. This study evaluated the specific features, outcomes, and predictors of L5/S1 ASD following lumbar spine surgery at a Nigerian tertiary centre. **Methods:** A retrospective cohort study of 311 patients who underwent lumbar spine surgery with fixation terminating at L5 at the National Orthopaedic Hospital Dala, Kano, from January 2019 to June 2025 was conducted. Sixty-three patients (20.3%) developed ASD over a minimum 1-year follow-up. Outcomes assessed included specific ASD features, management strategy (surgical vs conservative), patient satisfaction, and predictors of ASD and satisfaction. **Results:** The most common ASD features were disc degeneration (82.5%), facet joint arthropathy (68.3%), spinal stenosis (55.6%), and spondylolisthesis (36.5%). Twenty-eight patients (44.4%) underwent surgical extension to S1, with 3 (4.8%) requiring additional S2AI screw fixation. The remaining 35 patients (55.6%) were managed conservatively. Surgical patients had significantly better pain relief (VAS 2.8±1.4 vs 4.6±1.8, p<0.001) and functional outcomes (ODI 28.4±12.6 vs 42.6±15.2, p<0.001). Patient satisfaction was reported by 48 patients (76.2%), with surgical management (OR 3.2, 95% CI: 1.4–7.3) and shorter symptom duration (OR 2.6, 95% CI: 1.1–6.1) being independent predictors of satisfaction. Predictors of ASD included: fusion length ≥3 levels (OR 3.4, 95% CI: 1.6–7.2), preoperative disc degeneration at L5/S1 (OR 2.8, 95% CI: 1.3–6.1), and age >55 years (OR 2.4, 95% CI: 1.1–5.2). **Conclusions:** L5/S1 ASD occurs in 20.3% of patients following lumbar fusion terminating at L5. Surgical extension to S1 with or without S2AI screws provides superior outcomes compared with conservative management. Fusion length, preoperative L5/S1 degeneration, and older age are significant predictors of ASD.

Keywords: Adjacent Segment Disease; L5/S1; Lumbar Fusion; S2AI Screws; Patient Satisfaction; Nigeria

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1. Introduction

Adjacent segment disease (ASD) is a well-recognised long-term complication of lumbar spinal fusion, characterised by degenerative changes at the motion segment adjacent to a fused segment [1,2]. The reported incidence of ASD ranges from 5% to 40%, depending on the length of follow-up and the diagnostic criteria used [3,4]. The L5/S1 segment is particularly vulnerable to ASD when fusion terminates at L5, as it becomes the sole remaining mobile segment below the fusion and bears increased biomechanical stress [5,6].

The pathophysiology of ASD is multifactorial, involving a combination of altered biomechanics, natural degenerative progression, and patient-specific factors [7,8]. Biomechanical studies have demonstrated that fusion at L4-L5 significantly increases the range of motion and intradiscal pressure at L5/S1, accelerating degenerative changes [9,10]. A systematic review found that the incidence of ASD was higher in patients with fusion terminating at L5 compared with those with fusion extending to the sacrum, suggesting that the residual motion segment is at increased risk [11].

Clinical features of L5/S1 ASD include low back pain, radicular pain, neurogenic claudication, and functional disability [12,13]. Radiological features include disc degeneration, facet joint arthropathy, spinal stenosis, and spondylolisthesis [14,15]. A study from Nigeria on the pattern of spinal disorders found that degenerative conditions were the most common indication for lumbar fusion, with a significant proportion of patients developing ASD during follow-up [16].

The management of L5/S1 ASD depends on the severity of symptoms, the degree of neurological compromise, and the integrity of the L5/S1 segment. Conservative management, including physiotherapy, analgesics, and activity modification, is appropriate for mild symptoms [17,18]. Surgical intervention, typically involving extension of the fusion to S1, is indicated for severe symptoms, progressive neurological deficit, or significant instability [19,20]. The addition of S2-alar-iliac (S2AI) screws may be necessary for additional pelvic fixation in selected cases [21,22].

In resource-constrained settings such as Nigeria, the management of L5/S1 ASD is challenging due to limited access to revision implants, advanced imaging, and specialized surgical expertise [23,24]. The National Orthopaedic Hospital Dala, Kano, serves as a major referral centre for spinal disorders in northern Nigeria, managing a high volume of lumbar fusion procedures [25]. Understanding the specific features, outcomes, and predictors of L5/S1 ASD in this setting is essential for optimizing surgical decision-making and patient care.

This study aimed to: (1) determine the specific features of L5/S1 ASD following lumbar fusion terminating at L5; (2) evaluate the outcomes of surgical versus conservative management; and (3) identify predictors of ASD and patient satisfaction.

2. Methodology

2.1. Study Design and Setting

This was a retrospective cohort study conducted at the National Orthopaedic Hospital Dala, Kano, Nigeria -a 260-bed tertiary orthopaedic referral centre serving northern Nigeria. The study covered the period from 1 January 2019 to 30 June 2025. Ethical approval was obtained from the institutional research ethics committee and individual patient consent was waived due to the retrospective nature.

2.2. Participants

All consecutive patients who underwent lumbar spine surgery with pedicle screw fixation terminating at L5 during the study period were eligible. Inclusion criteria: (1) lumbar fusion with fixation terminating at L5; (2) minimum 1-year follow-up; (3) complete medical and radiological records. Exclusion: patients with fusion extending to the sacrum, previous lumbar surgery, tumour, infection, or incomplete records.

A total of 311 patients met the inclusion criteria. Of these, 63 patients (20.3%) developed L5/S1 ASD during follow-up.

2.3. Diagnosis of ASD

ASD was defined as the development of new or worsening degenerative changes at L5/S1, confirmed by MRI or CT, associated with clinical symptoms including low back pain, radicular pain, or neurogenic claudication. Radiological criteria included disc degeneration (Pfirrmann grade ≥ 3), facet joint arthropathy (Weishaupt grade ≥ 2), spinal stenosis (canal diameter < 10 mm), or spondylolisthesis (Meyerding grade ≥ 1).

2.4. Management of ASD

- Surgical management: Extension of fusion to S1 with pedicle screw fixation. S2AI screws were added when additional pelvic fixation was required for L5-S1 instability or sacral insufficiency.
- Conservative management: Physiotherapy, analgesics, activity modification, and bracing.

2.5. Data Collection

Data were extracted from patient case files, operative notes, and follow-up records. Variables collected included: age, sex, preoperative diagnosis, number of levels fused, preoperative L5/S1 disc degeneration, symptom duration, ASD features, management strategy, complications, and patient satisfaction.

2.6. Outcome Measures

- Pain: Visual Analogue Scale (VAS, 0–10).
- Functional disability: Oswestry Disability Index (ODI, 0–100).
- Patient satisfaction: Self-reported satisfaction with treatment outcome (satisfied = score ≥ 4 on 5-point Likert scale).

2.7. Statistical Analysis

Data were analysed using SPSS version 26. Continuous variables are presented as mean $\pm$ SD, categorical as frequencies (%). Comparisons between surgical and conservative groups used independent t-test or Mann-Whitney U for continuous variables, and chi-square or Fisher's exact for categorical variables. Univariate and multivariate logistic regression identified independent predictors of ASD and patient satisfaction. Variables with $p < 0.10$ in univariate analysis were entered into the multivariate model. Adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated. Statistical significance was set at $p < 0.05$.

3. Results

3.1. Patient Characteristics

A total of 311 patients were included, of whom 63 (20.3%) developed L5/S1 ASD. The mean age was 58.4 ± 11.6 years; 198 (63.7%) were male. The most common preoperative diagnosis was degenerative spondylolisthesis (42.4%), followed by spinal stenosis (34.1%) and disc herniation (23.5%). The mean number of levels fused was 2.8 ± 1.2 . [Table 1](#) presents the baseline characteristics.

Table 1. Baseline Characteristics of 311 Patients

Characteristic	Category	n (%)
	Mean±SD	58.4 ± 11.6
Age (years)	≤55 years	124 (39.9)
	>55 years	187 (60.1)
Sex	Male	198 (63.7)
	Female	113 (36.3)
Diagnosis	Degenerative spondylolisthesis	132 (42.4)
	Spinal stenosis	106 (34.1)
	Disc herniation	73 (23.5)
Levels fused	1–2 levels	186 (59.8)
	≥3 levels	125 (40.2)
Preoperative L5/S1 disc degeneration	Present	98 (31.5)
	Absent	213 (68.5)

3.2. Specific Features of L5/S1 ASD

Table 2 presents the specific features of L5/S1 ASD in the 63 patients who developed the condition. The most common features were disc degeneration (82.5%), facet joint arthropathy (68.3%), spinal stenosis (55.6%), and spondylolisthesis (36.5%). The mean time to ASD diagnosis was 28.4±8.6 months.

Table 2. Specific Features of L5/S1 ASD (n=63)

Feature	n (%)
Disc degeneration (Pfirschnann ≥3)	52 (82.5)
Facet joint arthropathy (Weishaupt ≥2)	43 (68.3)
Spinal stenosis (canal <10 mm)	35 (55.6)
Spondylolisthesis (Meyerding ≥1)	23 (36.5)
Radicular pain	48 (76.2)
Neurogenic claudication	31 (49.2)
Low back pain	58 (92.1)

3.3. Management and Outcomes

Table 3 presents the management and outcomes of L5/S1 ASD. Twenty-eight patients (44.4%) underwent surgical extension to S1, of whom 3 (4.8%) required additional S2AI screw fixation. The remaining 35 patients (55.6%) were managed conservatively. Surgical patients had significantly better pain relief (VAS 2.8±1.4 vs 4.6±1.8, $p<0.001$) and functional outcomes (ODI 28.4±12.6 vs 42.6±15.2, $p<0.001$).

Table 3. Management and Outcomes of L5/S1 ASD (n=63)

Outcome	Surgical (n=28)	Conservative (n=35)	p-value
VAS (0–10) mean±SD	2.8 ± 1.4	4.6 ± 1.8	<0.001
ODI (0–100) mean±SD	28.4 ± 12.6	42.6 ± 15.2	<0.001
Patient satisfaction n (%)	24 (85.7)	24 (68.6)	0.04
Complications n (%)	4 (14.3)	2 (5.7)	0.25

Complications in the surgical group included 2 cases of wound infection (7.1%), 1 case of screw loosening (3.6%), and 1 case of transient neurological deficit (3.6%). All were managed successfully.

3.4. Predictors of ASD

Table 4 presents the multivariate logistic regression analysis for predictors of ASD. Independent predictors included: fusion length ≥ 3 levels (adjusted OR 3.4, 95% CI: 1.6–7.2), preoperative L5/S1 disc degeneration (OR 2.8, 95% CI: 1.3–6.1), and age >55 years (OR 2.4, 95% CI: 1.1–5.2).

Table 4. Multivariate Logistic Regression – Predictors of L5/S1 ASD

Predictor	Adjusted OR	95% CI	p-value
Fusion length ≥ 3 levels	3.4	1.6 – 7.2	0.001
Preoperative L5/S1 disc degeneration	2.8	1.3 – 6.1	0.008
Age >55 years	2.4	1.1 – 5.2	0.03
Male sex	1.2	0.6 – 2.5	0.62
Preoperative diagnosis (spondylolisthesis)	1.4	0.7 – 2.9	0.38

3.5. Predictors of Patient Satisfaction

Table 5 presents the multivariate logistic regression analysis for predictors of patient satisfaction. Independent predictors included: surgical management (adjusted OR 3.2, 95% CI: 1.4–7.3), shorter symptom duration (<6 months) (OR 2.6, 95% CI: 1.1–6.1), and absence of complications (OR 2.1, 95% CI: 1.0–4.6).

Table 5. Multivariate Logistic Regression – Predictors of Patient Satisfaction

Predictor	Adjusted OR	95% CI	p-value
Surgical management	3.2	1.4 – 7.3	0.006
Symptom duration <6 months	2.6	1.1 – 6.1	0.02
Absence of complications	2.1	1.0 – 4.6	0.04
Age ≤ 55 years	1.5	0.7 – 3.2	0.30
Male sex	1.1	0.5 – 2.4	0.78

4. Discussion

This study provides the first comprehensive evaluation of L5/S1 ASD following lumbar fusion in a resource-constrained Nigerian centre. The incidence of 20.3% is consistent with the reported range of 5–40% in the literature [1,3,4]. The finding that fusion length ≥ 3 levels, preoperative L5/S1 disc degeneration, and age >55 years are independent predictors of ASD provides guidance for patient selection and surgical planning.

The 20.3% incidence of L5/S1 ASD in our cohort is comparable to the 18–25% reported in other studies with similar follow-up durations [11,14]. A systematic review found that the incidence of ASD was 11.6% at 5 years and 26.4% at 10 years [11]. The mean time to ASD diagnosis of 28.4 months in our cohort is consistent with the natural history of degenerative changes, which typically progress over 2–5 years [15].

The specific features of ASD in our cohort—disc degeneration (82.5%), facet joint arthropathy (68.3%), spinal stenosis (55.6%), and spondylolisthesis (36.5%)—are consistent with the literature [12,13,14]. A study by Park et al. found that disc degeneration was the most common feature of ASD, followed by facet joint arthropathy and stenosis [15]. The high prevalence of radicular pain (76.2%) and neurogenic claudication (49.2%) in our cohort reflects the clinical significance of these degenerative changes.

The finding that surgical management provided significantly better pain relief (VAS 2.8 vs 4.6) and functional outcomes (ODI 28.4 vs 42.6) is consistent with the literature [17,19]. A study on the surgical treatment of ASD found that extension of fusion to S1

provided significant improvement in pain and function compared with conservative management [19]. The addition of S2AI screws in 3 patients (4.8%) reflects the need for additional pelvic fixation in cases with significant L5-S1 instability or sacral insufficiency [21,22].

The complication rate of 14.3% in the surgical group is consistent with the reported range of 10–20% for revision lumbar surgery [20,23]. The complications—wound infection, screw loosening, and transient neurological deficit—were all managed successfully without long-term sequelae.

The identification of fusion length ≥ 3 levels as a predictor of ASD (OR 3.4) is consistent with the literature. A study by Lee et al. found that longer fusion constructs were associated with a higher incidence of ASD due to increased stress on the adjacent segment [11]. A biomechanical study demonstrated that multi-level fusion significantly increases the range of motion and intradiscal pressure at the adjacent segment [9,10].

Preoperative L5/S1 disc degeneration as a predictor (OR 2.8) highlights the importance of assessing the L5/S1 segment before surgery. A study by Park et al. found that preoperative disc degeneration at the adjacent segment was a significant predictor of ASD [15]. This finding supports the recommendation that patients with pre-existing L5/S1 degeneration should be counselled about the risk of ASD and considered for fusion extending to S1 at the index surgery.

Age >55 years as a predictor (OR 2.4) is consistent with the natural history of degenerative disc disease, which progresses with age [7,8]. A study by Kim et al. found that older age was an independent predictor of ASD [14].

The identification of surgical management as a predictor of satisfaction (OR 3.2) reflects the superior clinical outcomes achieved with surgical treatment. A study on patient satisfaction after revision lumbar surgery found that improvement in pain and function were the strongest predictors of satisfaction [26]. Shorter symptom duration (<6 months) as a predictor (OR 2.6) highlights the importance of early intervention before chronic pain and disability become established [27]. Absence of complications as a predictor (OR 2.1) underscores the impact of adverse events on patient experience [28].

The findings have several implications for clinical practice in resource-constrained settings:

1. Preoperative assessment: The L5/S1 segment should be carefully assessed preoperatively, particularly in patients with pre-existing disc degeneration. Consideration should be given to extending fusion to S1 in high-risk patients.
2. Fusion length: Limiting fusion length, when possible, may reduce the risk of ASD. However, this must be balanced against the need for adequate decompression and stabilisation.
3. Surgical management of ASD: Extension of fusion to S1, with or without S2AI screws, provides superior outcomes compared with conservative management and should be offered to patients with symptomatic ASD.
4. Early intervention: Patients with shorter symptom duration had better satisfaction, supporting early surgical intervention before chronic disability develops.
5. Patient counselling: Patients should be informed of the risk of ASD and the potential need for revision surgery during the consent process.

This study has several strengths, including a relatively large sample size ($n=311$), a minimum 1-year follow-up, and comprehensive assessment of ASD features and outcomes. The inclusion of both surgical and conservative management groups allows for comparison. However, limitations exist. The retrospective design introduces selection and information bias. The decision for surgical versus conservative management was not randomized, and healthier patients may have been selected for surgery. The study did not include long-term follow-up beyond the study period. The single-centre design may limit

generalizability to other Nigerian settings. The absence of a validated satisfaction instrument limits the interpretability of satisfaction outcomes.

Future prospective studies should evaluate the optimal timing and type of surgical intervention for L5/S1 ASD. The role of preoperative L5/S1 disc degeneration in guiding the decision to extend fusion to S1 warrants further investigation. Comparative studies of different surgical techniques (S1 alone vs S2AI screws) are needed to define the optimal strategy for different degrees of instability.

In conclusion, L5/S1 ASD occurs in 20.3% of patients following lumbar fusion terminating at L5 in a resource-constrained Nigerian centre. The most common features are disc degeneration, facet joint arthropathy, and spinal stenosis. Surgical extension to S1, with or without S2AI screws, provides significantly better pain relief and functional outcomes compared with conservative management. Independent predictors of ASD include fusion length ≥ 3 levels, preoperative L5/S1 disc degeneration, and age >55 years. Surgical management, shorter symptom duration, and absence of complications predict patient satisfaction. Preoperative assessment of the L5/S1 segment and consideration of fusion extending to S1 in high-risk patients are recommended.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

The project did not meet the definition of human subject research under the preview of the IRB according to federal regulations and therefore was exempt.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

All authors contributed equally to this paper.

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