Does SPECT/CT Change Management? Evaluating Its Role in the Post-Operative Spine

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INTRODUCTION: Low back pain (LBP) is the leading cause of years lived with disability worldwide. While many cases improve with conservative treatments like physical therapy or pain management, persistent or severe cases may require spinal fusion, with over 400,000 cases being performed annually in the US alone. Pseudarthrosis— the failure of bony fusion across the intended spinal levels at a minimum of 6 months post-op— remains a costly and disabling complication of spinal fusion, with rates ranging from 0% to over 60% depending on surgical approach, instrumentation, and number of levels fused. Diagnosing pseudarthrosis is challenging due to its vague or nonspecific presentation and the complex overlap with adjacent segment disease, infection, or other sources of axial pain. Recently, SPECT/CT has emerged as an adjunct imaging modality that has potential to complement conventional imaging (plain radiographs and CT or MRI) in the detection of pseudarthrosis, however, its diagnostic accuracy varies substantially between studies and patient subgroups. There is a lack of robust data on the clinical utility of SPECT/CT—namely, whether specific scan interpretations (true/false positive or negative) translate into changes in management after fusion and which patients benefit most. The present study evaluates the relationship between SPECT/CT findings and subsequent management decisions, with particular attention to surgical intervention, and explores whether patient and procedural factors—including time from fusion—modify these associations.

METHODS: A retrospective cohort study was performed at a single Level I trauma center after IRB approval (IRB-23-2104). We identified all adults who underwent instrumented spinal fusion between 2012 and 2022 and later received SPECT/CT for persistent symptoms. Patient-level data (n = 195) were used for baseline comparisons; procedure-level data (n = 203 cases) were used for management and imaging analyses. A change in management was defined as any new clinical action taken after SPECT/CT review—namely, initiation of non-surgical therapy, specialist referral, scheduling of revision surgery, or adjustment of follow-up frequency. Cases without any of these actions were classified as continued management. Predictor variables included sex, age at surgery, BMI, ASA class (<3 vs ≥3), number of fusion levels, time from fusion to SPECT/CT, spine region (cervical, thoracic, lumbar), and diagnostic outcome confirmed by surgical exploration or clinical course. Outcomes were classified as: true positive (TP) if SPECT/CT identified pseudarthrosis that was confirmed; true negative (TN) if solid fusion was shown or an asymptomatic course supported fusion; false positive (FP) if pseudarthrosis was suggested but fusion/asymptomatic course confirmed otherwise; and false negative (FN) if fusion was suggested but pseudarthrosis was later confirmed. Continuous variables (mean ± SD) were compared with t-tests or Wilcoxon rank-sum tests based on Shapiro–Wilk and Levene assessments; categorical variables (counts, %) were compared with Fisher's exact test. Two logistic-regression models were fitted: (1) predictors of any management change and (2) predictors of surgical revision (reference = TP). Covariates were age, sex, BMI, ASA class, number of levels, time from fusion, spine region, and SPECT/CT accuracy or outcome. Associations between SPECT/CT outcome and each specific management action were further examined with Fisher's exact tests. Analyses were conducted in RStudio (V2025.05.1+513); $p < 0.05$ denoted significance.

RESULTS: A total of 195 patients (74 males, 107 females) underwent spinal fusion and subsequent SPECT/CT imaging. Of these, 125 (64.1%) experienced a change in management, most commonly through initiation of non-surgical interventions (44.8%), surgical revision (30.0%), referral to a specialist (29.6%), or modification of follow-up frequency (14.8%). Baseline demographic characteristics did not differ significantly between patients with and without management changes (all $p > 0.05$; Table 1). No significant associations were observed between change in management and any measured covariate—including age, sex, BMI, ASA class, number of fusion levels, time from fusion to SPECT/CT, spine region, or overall SPECT/CT accuracy category—with all p values exceeding 0.05. SPECT/CT diagnostic outcome was significantly associated with the likelihood of surgical intervention (Fisher's exact test, $p < 0.001$), with surgery pursued in 60% of true positive, 84.6% of false negative, 50% of false positive, and only 13.4% of true negative SPECT/CT cases (Table 2). No significant associations were found between SPECT/CT outcome and non-surgical intervention, referral, or follow-up modification (all $p > 0.05$). In multivariate logistic regression, true negative SPECT/CT findings were independently associated with markedly lower odds of proceeding to surgery compared to true positive findings (OR = 0.10, 95% CI 0.05–0.23, $p < 0.001$; Figure 1), while odds for false negative and false positive results did not significantly differ from the true positive reference group.

DISCUSSION: SPECT/CT findings were strongly associated with subsequent management changes in post-fusion patients, particularly in guiding decisions regarding surgical intervention, while true negative SPECT/CT results significantly reduced the likelihood of additional intervention. These findings support the role of SPECT/CT in the diagnostic workup of persistent pain after spinal fusion and highlight the clinical value of imaging accuracy in decision-making. Study limitations include its retrospective design and single-institution cohort, which may limit external validity. We mitigated these weaknesses by using clearly defined management-change criteria and multivariable models that adjusted for key demographic and surgical factors. Further studies are needed to characterize these results and determine which patients—and at what postoperative timepoints—derive the greatest clinical benefit from SPECT/CT.

SIGNIFICANCE/CLINICAL RELEVANCE: Persistent pain after spinal fusion poses a significant diagnostic and management challenge. This study demonstrates that SPECT/CT imaging provides clinically actionable information that directly impacts treatment decisions, supporting its integration into the diagnostic pathway for complex post-fusion patients.

IMAGES AND TABLES:

Table 1: Baseline demographic characteristics of patients undergoing spinal fusion with SPECT/CT.
M= Male, C=Cervical, T=Thoracic, L=Lumbar

Characteristic (Mean)	Change (n = 125)	No Change (n = 70)	P-value
Sex; Males, n (%)	M: 49 (39.2%)	M: 31 (44.3%)	0.545
Age at SPECT/CT ± SD	65.28 ± 11.47	65.95 ± 13.36	0.510
BMI ± SD	30.37 ± 6.77	30.38 ± 5.61	0.642
Fusion Levels ± SD	2.4 ± 2.04	1.97 ± 1.22	0.411
Spine Region, n (%)	C: 35 (28%) T: 7 (5.6%) L: 83 (66.4%)	C: 23 (32.9%) T: 1 (1.4%) L: 46 (65.7%)	0.368
ASA <3, n (%)	58 (46.8%)	30 (43.5%)	0.763

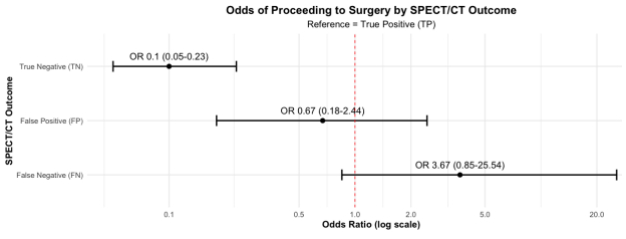

Figure 1: Odds of proceeding to surgery based on SPECT/CT diagnostic outcome, using true positive (TP) results as the reference category. Odds ratios (OR) with 95% confidence intervals are displayed on a logarithmic scale.