Pedicle Screw-Associated Violation of the Adjacent Unfused Facet Joint: Clinical Outcomes and Fusion Rates

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INTRODUCTION: Lumbar spine pedicle screws are the most commonly utilized implants for providing immediate spinal stability during fusion surgery. Ideal pedicle screw positioning includes avoiding violation of any adjacent unfused facet joints. Nevertheless, inadvertent screw malposition and screw-associated violation of adjacent facet joints (FJV) remains a potential complication of the procedure regardless of whether surgery is performed in open fashion or with minimally invasive techniques and despite the use of intraoperative imaging or surgical navigation. Given the proximity of the lumbar vertebral pedicle to the proximal facet joint, FJV occurs almost exclusively at the level of the proximal as opposed to the distal unfused spinal segment, and the rate of FJV in previous series has been reported as ranging from 2.8-100%. Although previous studies have suggested that FJV is associated with worse post-operative patient reported outcomes (PROs) in terms of low back pain and disability, there is no published data regarding the potential impact of FJV on postoperative radiologic fusion rates. The goal of this study was to compare both PROs as well as one-year postoperative CT-based fusion rates in patients undergoing single-level posterior instrumented fusion surgery with and without FJV.

METHODS:
Clinical outcomes data and CT imaging were reviewed for 157 patients participating in a multicenter prospective trial (Table 1). Inclusion criteria were age greater than 18 years and patients with single-level lumbar degenerative disease. Post-operative CT scans at 12-months follow-up were examined for fusion status and FJV. Patient-reported outcomes (PROs) included Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for leg and low back pain. Chi-square test of independence was used to compare proportions between groups on categorical measures. Two-sample t-test was used to identify differences in mean patient outcome scores. Logistic regression models were performed to determine association between FJV and fusion rates.
RESULTS:
There was no difference in preoperative ODI, VAS leg pain or VAS back pain scores comparing patients in Groups A and B (48.9 vs 49.5, p=0.884; 7.5 vs. 7.6, p=0.792; 7.4 vs. 7.4, p=0.996, respectively). Although marked postoperative improvement was observed in both Group A and B patients in terms of all clinical outcome measures, significantly worse mean one-year postoperative scores for ODI (28.1 vs. 15.5; p=0.004) and VAS back pain (3.9 vs. 2.1; p=0.04), but no difference in VAS leg pain (3.0 vs. 2.5, p=0.4997) were observed in Group A patients compared with Group B (Tables 2 and 3). The rate of fusion at 12-months for patients with FJV (27.8%) was markedly lower compared to those without FJV (71.2%) (p=0.0002). Patients with FJV were 76% less likely to have a successful fusion at 12-months.
DISCUSSION AND CONCLUSION: To our knowledge, there has been no published data regarding the potential association between FJV and fusion rates. Our study identified a relatively high rate (11.5%) of FJV in this prospective multicenter cohort of patients undergoing traditional open single-level posterior lumbar fusion, however this is consistent with previous rates reported in the literature. Previous studies regarding FJV at the most proximal level of a construct have focused mostly on pain generation and accelerated adjacent segment degeneration and disease. Consistent with previous studies, patients in our study with FJV demonstrated significantly worse ODI (28.1 vs. 15.5; p=0.003) and VAS back pain (3.9 vs. 2.1; p=0.036) at 12 months compared to patients without FJV. Pedicle screw-associated violation of the adjacent unfused facet joint following fusion surgery may be associated with an up to 76% decrease in fusion rate based on 1-year postoperative CT and less postoperative improvement in back pain severity and back pain-associated disability.

Table 1: Patient demographics and characteristics by group

	Group A (Yes FJV)	Group B (No FJV)	p-value
No. subjects (%)	18 (11.5%)	139 (88.5%)	
Female (%)	6/13 (46.1%)	74/131 (56.5%)	0.47
Age, mean ± standard deviation (range) (years)	48.4 ± 13.5 (31-76)	58.9 ± 13.1 (25-82)	0.009
Surgery Technique (%)			0.16
TLIF + PLF	10 (55.6%)	53 (38.1%)	
PLF	8 (44.4%)	86 (61.9%)	
Surgical level			0.033
L2-3	0	2 (1.4%)	
L3-4	1 (5.6%)	12 (8.6%)	
L4-5	7 (38.9%)	93 (66.9%)	
L5-S1	10 (55.6%)	32 (23.0%)	
Spondylolysis (%)	5 (29.4%)	15 (11.3%)	0.038
Spondylolisthesis (%)	11 (61.1%)	88 (64.7%)	0.76
Sponvdlolisthesis grade (%)			0.11
Grade 0	7 (38.9%)	51 (36.7%)	
Grade 1	9 (50%)	85 (61.2%)	
Grade 2	2 (11.1%)	3 (2.2%)	
Grade 3-5	0	0	
Mean Preop PROM (SD)			
ODI	48.9 (17.0)	49.5 (13.1)	0.884
VAS, leg pain	7.5 (1.6)	7.6 (2.2)	0.792
VAS, back pain	7.4 (2.3)	7.4 (2.2)	0.996

FJV – Facet Joint Violation; TLIF – Transforaminal Lumbar Interbody Fusion; PLF – Posterolateral Fusion; PRO – Patient-Reported Outcome Measure; VAS – Visual Analog Score. Spondylolisthesis grading based on the Meyerding classification.

Table 2: Fusion Rates and Mean Outcome Scores at 12-Months Follow-Up

	Group A (Yes FJV), n=18	**Group B** (No FJV), n=139	p-value
Yes Fusion, N (%)	5 (27.8%)	99 (71.2%)	0.0002448
ODI, mean (SD)	28.1 (22.1)	15.5 (15.3)	0.0037586
VAS leg pain, mean (SD)	3.0 (2.9)	2.5 (3.2)	0.4997072
VAS back pain, mean (SD)	3.9 (2.9)	2.1 (2.6)	0.0366391

FJV – Facet Joint Violation; ODI – Oswestry Disability Index; VAS – Visual Analog Scale

Table 3: Mean patient reported outcomes by group

	Group A (FJV)	Group B (No FJV)	p-value
ODI			
Preop	48.9	49.5	0.884
12 months	28.1	15.5	0.003
Total change	-21	-33.5	0.015
VAS leg			
Preop	7.5	7.6	0.792
12 months	3.0	2.5	0.499
Total change	-4.4	-5.1	0.493
VAS back			
Preop	7.4	7.4	0.996
12 months	3.9	2.1	0.036
Total change	-3.4	-5.2	0.073

FJV – Facet Joint Violation; ODI – Oswestry Disability Index; VAS – Visual Analog Scale