Interventional Pain Medicine 5 (2026) 100745

Contents lists available at ScienceDirect

Interventional Pain Medicine

journal homepage: www.journals.elsevier.com/interventional-pain-medicine

Evaluating prognostic block selection criteria in lumbar medical branch radiofrequency neurotomy: A retrospective cohort study

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A B S T R A C T

Background: Patient selection for lumbar medial branch radiofrequency neurotomy (LMBRFN) remains a topic of debate. Different block paradigms may influence LMBRFN outcomes. This study examined the relationships between block paradigms and treatment results following LMBRFN.

Methods: A retrospective cohort study of consecutive patients undergoing first-time LMBRFN between 2016 and 2022 at two associated Canadian clinics was performed. Patients were grouped into six prognostic block paradigms based on block type (medial branch block [MBB] vs. intra-articular block [IAB]), number of blocks (single vs. dual), and percent pain relief (50–79% vs. ≥80%): 1 = MBB/MBB ≥80%, 2 = MBB/MBB 50–79%, 3 = IAB/MBB ≥80%, 4 = IAB/MBB 50–79%, 5 = MBB ≥80%, and 6 = MBB 50–79%. Treatment success was defined by (1) ≥50% reduction in numerical rating scale (NRS) pain score and (2) the minimal clinically important difference (MCID) in Pain Disability Quality-of-Life Questionnaire–Spine (PDQQ-S) at 3 months post-procedure. Logistic regression was used to assess associations between block paradigm and outcomes while controlling for select demographic and clinical factors.

Results: Among 631 included patients (57.1% female; mean age 62.3 ± 12.9 years), 46.9% achieved ≥50% NRS reduction and 47.7% met the MCID for PDQQ-S at 3 months. No significant associations were found between block paradigms and ≥50% pain relief. However, the IAB/MBB 50–79% paradigm was associated with significantly lower odds of functional improvement by the PDQQ-S (OR = 0.31; $p = 0.02$). Patients who were working at the time of the procedure had higher odds of treatment success with respect to pain (OR = 2.51; $p < 0.01$) and function (OR = 2.21; $p < 0.01$).

Conclusion: In this cohort, nearly half of patients experienced clinically meaningful pain reduction at 3 months post-LMBRFN, regardless of block selection criteria, challenging the need for restrictive paradigms. However, patients selected by IAB/MBB with 50–79% pain relief were less likely to experience clinically significant improvements to function. Active employment was linked to better 3-month outcomes for both pain and function, highlighting potential psychosocial factors. Larger prospective studies with long-term follow-up are needed to confirm these findings and optimize patient selection for LMBRFN.

1. Introduction

Spinal pain is a prevalent condition that affects millions of individuals worldwide, significantly impacting quality of life and contributing to substantial healthcare costs [1,2]. Among the various types of spinal pain, lumbar spinal pain is the most common, with studies indicating that up to 80% of individuals experience low back pain at some point in their lives [3]. Facetogenic pain, which arises from the zygapophyseal (facet) joints, is a frequent source of chronic low back pain [4]. Effective management of this condition is crucial, as it can lead to disability, reduced mobility, and reliance on long-term analgesic use [5].

Lumbar medial branch radiofrequency neurotomy (LMBRFN) is a common procedure that dates back several decades and is widely used to treat chronic lumbar facetogenic pain [6–11]. By applying thermal energy to denervate the medial branches innervating the facet joints, LMBRFN has been shown to provide significant pain relief, improve function, and reduce the need for analgesic medications [12,13].

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https://doi.org/10.1016/j.inpm.2026.100745
Received 18 November 2025; Received in revised form 12 February 2026; Accepted 18 February 2026
Available online 25 February 2026

Despite the recognized effectiveness of LMBRFN, optimal patient selection for this procedure remains a subject of ongoing debate, with conflicting recommendations from payors and society guidelines. While the multi-specialty consensus guidelines for facet interventions recommend ≥50% pain relief with prognostic blocks as the cutoff to proceed to LMBRFN [14], CMS policy requires a more stringent eligibility threshold of ≥80% pain relief with blocks [15]. Since non-radicular low back pain can arise from multiple structures—including facet joints, intervertebral discs, paraspinal muscles, and vertebral bodies—assessing the likelihood of a patient's response to LMBRFN through temporary anesthetic blocks is commonly used in clinical practice [16]. Various prognostic block paradigms have been used in the research literature and real-world clinical practice to identify suitable candidates, differing in block type (medial branch versus intra-articular blocks), the number of blocks performed (single or dual), and the pain relief cut-off threshold considered a positive response [14,17,18]. However, few studies have clearly demonstrated a correlation between commonly utilized block strategies and treatment outcomes in a single cohort, and selection criteria vary widely across clinical practices.

Understanding which block paradigms best predict successful outcomes following LMBRFN is essential for improving patient care and access to effective treatment options. Additionally, factors such as patient demographics and baseline functional status may influence treatment response.

This study aims to evaluate the effectiveness of LMBRFN in a single cohort while investigating associations between outcomes and potential predictors of successful treatment, including various block-based selection paradigms, patient demographic factors, and clinical variables. The findings of this research may be used to help refine clinical decision-making and optimize treatment strategies for patients suffering from chronic lumbar facet pain.

2. Methods

This retrospective cohort study was conducted at two Canadian musculoskeletal and pain clinics within a single practice. Local approval by the Conjoint Health Research Ethics Board at the University of Calgary (Ethics ID: REB20-0355) was obtained. The electronic medical records of consecutive patients who underwent first-time LMBRFN between 2016 and 2022 were reviewed. A single interventionalist (author R.B.) performed the vast majority of the prognostic blocks and LMBRFN procedures at two outpatient clinic sites.

Data extraction was performed by two authors (R.B. and A.A.) The inclusion criteria were: (a) mechanical low back pain that had been refractory to conventional conservative treatment, (b) clinical features suggestive of facet joint involvement (*i.e.*, non-radicular pain, tenderness in lumbar paraspinals, positive Kemp test), (c) fluoroscopically-guided prognostic blocks with 50% or more pain relief, (d) first-time LMBRFN procedure only (repeat procedures excluded), and (e) Numerical Rating Scale (NRS) and Pain Disability Quality-of-Life Questionnaire–Spine (PDQQ-S) scores recorded from pre-LMBRFN and at 3 months post-intervention. The exclusion criteria were: (a) prognostic blocks performed >3 years before the LMBRFN procedure, (b) the cannula used was outside the scope of this study (*i.e.*, 18G or 20G cannula), (c) prognostic blocks performed offsite (d) confounding intervention or injury (*i.e.*, epidural or sacroiliac joint steroid injection), in the interim between LMBRFN and follow-up, or (e) the LMBRFN was performed coincidingly with a sacroiliac intervention on the same date.

2.1. Procedures

2.1.1. Lumbar Medial Branch Blocks (MBBs)

Patients were positioned face-down on a standard fluoroscopy table, and the area of the lumbar spine was then exposed, cleaned, and prepared in sterile fashion according to standard practices. Fluoroscopic imaging was utilized to identify the correct lumbar levels for the procedure. A 22- or 25-gauge needle was carefully advanced under fluoroscopic guidance to the specific nerve target sites. These sites included the junction where the medial transverse processes meet the superior articular processes of the L2, L3, L4, or L5 vertebrae, aiming for the L1, L2, L3, or L4 medial branch nerves, respectively, and the sacral ala - S1 superior articular process junction for the L5 dorsal ramus. The placement of the needle was verified using both ipsilateral oblique and anterior-posterior (AP) fluoroscopy views, and a small volume of contrast dye was injected to ensure accurate contrast flow without vascular uptake. Afterward, either 0.5 mL of 2% lidocaine or 0.5% bupivacaine was administered. The specific local anesthetic used was not disclosed to the patients. Upon discharge, patients were given a 6-h pain diary to record their pain relief and functional improvement.

2.1.2. Facet Joint Intra-Articular Blocks (IABs)

Patients were placed face-down on a standard fluoroscopy table, and the area of the lumbar spine was then exposed, cleaned, and prepared in sterile fashion according to standard procedures. A 22- or 25-gauge needle was carefully advanced under fluoroscopic guidance to the target facet joints. The ipsilateral oblique view was initially used to optimize the view of the target joints, and multiplanar views were used to confirm positioning. Next, approximately 0.5 mL of either 2% lidocaine or 0.5% bupivacaine with 0.5 mL of 40 mg/mL triamcinolone was administered. Upon discharge, patients were given a 6-h and 2-week pain diary to record their pain relief and functional improvement.

2.1.3. LMBRFN

Candidates reporting ≥50% pain relief with at least one MBB proceeded to LMBRFN. Conventional thermal radiofrequency neurotomy was performed at 80 °C using a lesion time of 120 s following a 30-s ramp-up time. The cannulae utilized were: conventional 16-gauge cannula with a 1-cm curved active tip; multi-tined Trident® (Avanos Medical); or multi-tined Nimbus® (Stratus Medical) cannula. The 16-gauge conventional cannula was placed parallel to the medial branch for all lumbar medial/L5 dorsal ramus nerves, whereas the multi-tined cannulae were placed perpendicular to the target medial branch/L5 dorsal ramus nerves.

2.2. Outcome assessment

Patient selection paradigms were categorized based on the number (single vs. dual) and type (MBB vs. IAB) of prognostic blocks, as well as subsequent percentage pain relief based on patient-reported NRS pain scores collected pre-versus post-block. Percentage pain reduction from baseline in response to blocks was calculated using the lowest NRS pain score recorded within 6 h post-injection. Using this schema, six block paradigms were established: (1) MBB/MBB ≥80%, (2) MBB/MBB 50–79%, (3) IAB/MBB ≥80%, (4) IAB/MBB 50–79%, (5) MBB ≥80%, and (6) MBB 50–79%. Outcomes for pain and function were evaluated at 3 months post-procedure using (a) an 11-point NRS scale [19] and (b) the Pain Disability and Quality of Life Questionnaire–Spine (PDQQ-S), which is a validated six-question patient-reported outcome measure designed for use in the field of minimally invasive interventional spine care, for which the minimal clinically important difference (MCID) is a score decrease of ≥17 points from baseline [20–22]. Treatment success was defined by two categorical outcome measures: (1) a primary study outcome of the proportion of participants with ≥50% reduction in NRS, and (2) a secondary outcome of the proportion of participants who reported the MCID (≥17-point decrease) on PDQQ-S. Logistic regression analyses were used to explore the relationships between block criteria and treatment success following LMBRFN, with resultant calculation of odds ratios (ORs) and 95% confidence intervals (CIs). The predictive value of select patient demographic variables and procedural characteristics for determining treatment success was also assessed using logistic regression models. The covariates included patient age, BMI, gender, smoking, exercise, employment (working, not working, or

retired), LMBRFN laterality (unilateral or bilateral), and RF cannula type (16g, Trident, or Nimbus).

3. Results

A total of 631 consecutive patients met the inclusion criteria and were analyzed. Patient demographics, clinical characteristics, and procedure-related variables are described in Table 1. The sample composition was 57.1% female with a mean age of 62.3 ± 12.9 years and mean BMI of 30.0 ± 6.8 kg/m^2. Distribution of the six block criteria was as follows: (1) 28.8% MBB/MBB ≥80%, (2) 33.1% MBB/MBB 50–79%, (3) 2.7% IAB/MBB ≥80%, (4) 5.4% IAB/MBB 50–79%, (5) 17.4% MBB ≥80%, and (6) 12.5% MBB 50–79%. The majority of LMBRFN procedures (85.7%) were performed with the Trident cannula, followed by 12.1% with the conventional 16-gauge cannula, and 2.2% with a Nimbus cannula. Bilateral procedures accounted for 78.5% of all cases.

Primary and secondary study outcomes are summarized in Table 2. At 3 months post-LMBRFN, 46.9% of patients (95% CI: 43.1–50.8) reported ≥50% NRS reduction, while 47.7% (95% CI: 43.8–51.6) met the responder definition on PDQQ-S with a ≥17-point improvement. Logistic regression analysis revealed no statistically significant associations between ≥50% NRS reduction and any of the six block paradigms ($p > 0.05$). Patients who identified as currently working had significantly higher odds of achieving treatment success, with an OR of 2.51 ($p < 0.01$) for ≥50% NRS reduction and 2.21 ($p < 0.01$) for ≥17-point improvement on PDQQ-S. Block paradigm IAB/MBB 50–79% was associated with reduced odds of achieving the MCID on PDQQ-S (OR = 0.31; $p = 0.02$) (see Table 3).

Table 1
Participant demographics, clinical characteristics, and procedural variables (N = 631).

Variable	No. (%)
Gender	
Male	271 (43.0)
Female	360 (57.1)
Current smoking	
Yes	386 (82.3)
No	83 (17.7)
Missing	*162*
Exercise	
Yes	177 (38.7)
No	281 (61.4)
Unknown	*173*
Working	
Yes	181 (39.7)
No	89 (19.5)
Retired	186 (40.8)
Unknown	*175*
Workup	
Internal	474 (75.2)
External	156 (24.8)
Unknown	*1*
Clinic	
Practice 1	267 (42.3)
Practice 2	364 (57.7)
Block type	
MBB/MBB ≥80%	182 (28.8)
MBB/MBB 50–79%	209 (33.1)
IAB/MBB ≥80%	17 (2.7)
IAB/MBB 50–79%	34 (5.4)
MBB ≥80%	110 (17.4)
MBB 50–79%	79 (12.5)
Cannula type	
16 g	76 (12.1)
Trident	540 (85.7)
Nimbus	14 (2.2)
Unknown	*1*
Laterality	
Unilateral	136 (21.6)
Bilateral	495 (78.5)
Age in years (n = 631); mean (SD)	62.3 (12.9)
Body mass index in kg/m^2 (n = 439); mean (SD)	30.0 (6.8)
Pain duration in years (n = 455); mean (SD)	14.0 (13.3)

IAB = intra-articular block; MBB = medial branch block; SD = standard deviation.

Table 2
Patient-reported outcomes.

Outcome	No. (%)	95% CI (yes)
≥ 50% NRS reduction		
Yes	296 (46.9)	43.1, 50.8
No	335 (53.1)	
≥ 17-point PDQQ-S reduction		
Yes	301 (47.7)	43.8, 51.6
No	330 (52.3)	

CI = confidence interval; NRS = Numerical Rating Scale; PDQQ-S = Pain Disability and Quality of Life Questionnaire–Spine.

4. Discussion

This study represents the largest single-cohort analysis of variables associated with LMBRFN outcomes to date. In this cohort, nearly half of patients selected by six different block paradigms for first-time LMBRFN went on to experience ≥50% reductions in pain (46.9%) and meaningful improvement in function and quality of life (47.7%) at 3-month follow-up. While logistic regression analyses largely demonstrated no associations between block selection criteria and successful outcomes, patients selected with the IAB/MBB 50–79% paradigm were significantly less likely to achieve the MCID on PDQQ-S at 3 months. These findings suggest that MBB-based selection criteria may be more reliable predictors of LMBRFN success than intra-articular block or mixed IAB/MBB paradigms.

To our knowledge, this is the first study to directly compare LMBRFN outcomes across different block-based selection criteria within a single study population. A systematic review by Schneider et al. [23] previously stratified LMBRFN outcomes by block technique; however, those comparisons were drawn from multiple heterogeneous studies, limiting the ability to draw direct conclusions regarding the superiority of any specific block technique. In contrast, our single-cohort analysis demonstrated no statistically significant differences in the predictive value of MBBs for post-LMBRFN outcomes, regardless of block number (single vs. dual) or pain relief threshold (50–79% vs. ≥80%). Although both variations of the IAB/MBB paradigm we assessed produced comparable outcomes overall, their predictive consistency was less robust. Certain subsets of patients undergoing IAB/MBB, particularly those with 50–79% pain relief, may go on to experience less favorable outcomes than patients demonstrating ≥50% pain reduction with single or dual MBBs. These findings suggest that patient selection should rely primarily on the MBB response, as certain intra-articular paradigms appear to be associated with diminished post-LMBRFN outcomes.

While large-scale studies with longer follow-up durations are warranted to confirm our results, this study shows that a wider set of block paradigms may be equally associated with LMBRFN success. Adherence to more stringent paradigms such as the one required for insurance coverage by most United States payer types—two consecutive MBBs with ≥80% pain relief [15]—may be limiting access to LMBRFN for patients who would be equally likely to experience significant pain relief and functional improvement despite only achieving 50–79% pain relief. Despite current coverage policies [15] and society guidelines [9] favoring dual prognostic blocks before LMBRFN, our findings more closely align with the multi-specialty consensus guidelines on facet interventions [14], which suggest that a single lumbar MBB may adequately identify treatment responders. Eliminating the second block could reduce patient burden—minimizing procedural risk, time away from work, and treatment delays—while also decreasing healthcare

Table 3
Logistic regression models on study outcomes.

Outcome	Predictor	OR	95% CI	*p*
≥50% NRS reduction	**Gender** (vs. male)			
	Female	1.23	0.81, 1.86	0.33
	Exercise (vs. no)			
	Yes	1.01	0.66, 1.53	0.98
	Working (vs. not working)			
	Yes	2.51	1.38, 4.54	**<0.01**
	Retired	1.17	0.59, 2.30	0.66
	Smoking (vs. no)			
	Yes	0.87	0.49, 1.54	0.63
	Laterality (vs. unilateral)			
	Bilateral	0.80	0.47, 1.34	0.39
	Block type (vs. MBB/MBB ≥80%)			
	MBB/MBB 50–79%	0.65	0.38, 1.11	0.12
	IAB/MBB ≥80%	0.79	0.26, 2.39	0.67
	IAB/MBB 50–79%	0.41	0.14, 1.21	0.11
	MBB ≥80%	1.17	0.61, 2.24	0.63
	MBB 50–79%	0.77	0.39, 1.52	0.45
	Cannula type (vs. 16g)			
	Trident	0.97	0.50, 1.91	0.94
	Nimbus	0.80	0.19, 3.30	0.75
	Age	1.02	0.99, 1.04	0.12
	BMI	1.01	0.98, 1.05	0.36
≥17-point PDQQ-S reduction	**Gender** (vs. male)			
	Female	1.17	0.77, 1.78	0.47
	Exercise (vs. no)			
	Yes	1.31	0.86, 2.00	0.20
	Working (vs. not working)			
	Yes	2.21	1.23, 3.99	**<0.01**
	Retired	1.11	0.56, 2.19	0.76
	Smoking (vs. no)			
	Yes	1.46	0.82, 2.57	0.20
	Laterality (vs. unilateral)			
	Bilateral	0.76	0.45, 1.29	0.31
	Block type (vs. MBB/MBB ≥80%)			
	MBB/MBB 50–79%	0.59	0.35, 1.01	0.05
	IAB/MBB ≥80%	0.77	0.26, 2.29	0.64
	IAB/MBB 50–79%	0.31	0.10, 0.94	**0.02**
	MBB ≥80%	1.25	0.65, 2.39	0.50
	MBB 50–79%	0.83	0.43, 1.62	0.59
	Cannula type (vs. 16g)			
	Trident	0.80	0.41, 1.57	0.52
	Nimbus	1.11	0.28, 4.41	0.88
	Age	1.02	0.99, 1.04	0.12
	BMI	1.02	0.99, 1.05	0.28

CI = confidence interval
IAB = intra-articular block; MBB = medial branch block; NRS = Numerical Rating Scale; OR = odds ratio; PDQQ-S = Pain Disability and Quality of Life Questionnaire–Spine.

utilization and cost. Furthermore, expedited access to definitive treatment may mitigate prolonged pain, lost productivity, emergency department visits, and increased analgesic use associated with chronic low back pain.

Our results are aligned with previous studies examining outcomes of LMBRFN performed with newer multi-tined technology. In a recent retrospective cohort of 174 patients with a comparable demographic, Rachdi et al. reported that 50.6% achieved at least 50% NRS reduction and 50.0% met the MCID on the PDQQ-S at 3 months [24]. Similarly, Kunzle et al. studied LMBRFN with a three-tined perpendicular cannula in 44 patients and found that 41% achieved ≥50% pain reduction at 2 months, with 48% rating themselves as "much improved" on the PGIC scale [25]. In a within-subject comparative observational study, Deng et al. examined outcomes and procedural characteristics of 51 patients who had undergone multiple LMBRFN procedures to treat the same lumbar facet joint(s) on separate occasions using a three-tined cannula versus a conventional 16-gauge monopolar cannula [26]. They found that 3-month responder rates for ≥50% NRS reduction were 57% with the three-tined cannula and 52% with the conventional cannula; however, this difference was not statistically significant. Additionally, the three-tined cannula was associated with shorter procedure times, smaller volumes of local anesthetic, and decreased radiation exposure.

In the present study, the majority (85.7%) of procedures were performed using the multi-tined Trident cannula, reflecting increasing adoption of this newer technology in clinical practice. Although our analysis did not reveal statistically significant differences in pain or functional outcomes between Trident and conventional 16g cannulae, the consistent benefits observed support the Trident as at least equally effective as conventional monopolar cannulae [26,27]. These findings further reinforce the growing evidence that LMBRFN with the three-tined cannula offers consistent and clinically meaningful pain relief at 3 months post-LMBRFN. We are cognizant of the concern relating to treatment effect durability identified with cervical facet joint radiofrequency neurotomy using a three-tined cannula and perpendicular approach to the medial branch nerve [28]. Further research to determine if this concern applies to LMBRFN is warranted.

Importantly, we found that employment status was a strong predictor of treatment response. Employed patients were more than twice as likely to experience both meaningful pain relief and functional improvement at 3 months. This finding aligns with literature suggesting that active employment correlates with improved outcomes across multiple pain interventions, potentially due to greater physical activity, improved mental health, and reduced secondary gain concerns [29,30]. It also reinforces the role of biopsychosocial factors in modulating response to interventional pain therapies.

5. Limitations

This study has several limitations that should be acknowledged. As a single-arm retrospective cohort conducted at two affiliated centers, the lack of a comparison or control group limits the ability to attribute observed outcomes solely to the intervention and to fully account for potential confounders. Additionally, selection of prognostic block paradigms was based on clinician judgment rather than a standardized or randomized protocol. As a result, patient characteristics that influenced the choice of block paradigm may have overlapped with factors

associated with treatment response, introducing potential selection bias or residual confounding. The relatively short follow-up period of 3 months also constrains assessment of long-term treatment durability. The primary objective of this investigation was to identify variables associated with successful LMBRFN outcomes, which can be reasonably evaluated at 3 months; however, confirmation of these associations over longer durations remains necessary. Notably, a recent study reported differential outcomes at 6 and 12 months between conventional and multi-tined cervical RFN, with the conventional technique demonstrating superior durability [28]. Future prospective, randomized studies with follow-up periods extending to 12–24 months are warranted to better characterize the long-term efficacy, durability, and safety of LMBRFN.

6. Conclusion

In this cohort, approximately half of patients undergoing LMBRFN achieved clinically meaningful improvements in pain and function at 3 months. Each of the single- and dual-block MBB paradigms demonstrated comparable rates of treatment success, challenging the common notion that more restrictive block paradigms yield better outcomes. However, patients selected for LMBRFN using the IAB/MBB paradigm with 50–79% pain relief exhibited significantly lower odds of functional improvement, as measured by the MCID on the PDQQ-S instrument. Active employment status was positively associated with treatment success, highlighting the potential influence of psychosocial and behavioral factors on procedural outcomes. Collectively, these findings support an individualized approach to patient selection for LMBRFN and underscore the need for larger, prospective studies with extended follow-up to validate these results and refine patient selection and procedural methodology.

Funding

None.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Zachary McCormick reports a relationship with International Pain & Spine Intervention Society that includes: board membership. Zachary McCormick reports a relationship with Avanos Medical Inc that includes: consulting or advisory and funding grants. Zachary McCormick reports a relationship with Boston Scientific Corporation that includes: funding grants. Zachary McCormick reports a relationship with Relievant Medsystems Inc that includes: funding grants. Zachary McCormick reports a relationship with Saol Therapeutics that includes: consulting or advisory and funding grants. Zachary McCormick reports a relationship with Spine Biopharma that includes: funding grants. Zachary McCormick reports a relationship with SPR Therapeutics Inc that includes: funding grants. Zachary McCormick reports a relationship with Stratus Medical that includes: funding grants. Zachary McCormick reports a relationship with Stryker that includes: consulting or advisory. Zachary McCormick reports a relationship with OrthoSon that includes: consulting or advisory. Allison Glinka Przybysz reports a relationship with Medtronic that includes: funding grants. Aaron Conger reports a relationship with Stratus that includes: funding grants. Taylor Burnham reports a relationship with Diros Technology Inc that includes: funding grants. Taylor Burnham reports a relationship with Avanos Medical Inc that includes: consulting or advisory. Founder and CEO of STATIX, LLC, an independent research consulting company - Brook Martin Deputy Editor of Evidence and Methods for The Spine Journal - Brook Martin If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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