

Feasibility and Analgesic Outcomes of Surgically Placed Erector Spinae Plane Catheters in Chronic Pain Patients Undergoing Posterior Spinal Fusion

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Abstract

Background

Posterior spinal fusion surgery is associated with substantial postoperative pain, high opioid requirements, and delayed recovery. Although erector spinae plane (ESP) blocks have emerged as opioid-sparing analgesic techniques, evidence regarding continuous surgeon-placed ESP catheters remains limited.

Objective

To evaluate feasibility and postoperative analgesic outcomes associated with surgically placed continuous ESP catheters in chronic pain patients undergoing posterior spinal fusion surgery.

Methods

This retrospective observational study included chronic pain patients who underwent posterior spinal fusion between 2022 and 2025 and received bilateral ESP catheters placed intraoperatively under direct surgical visualization. Catheters were managed postoperatively with continuous ropivacaine infusions by the Acute Pain Service. Primary outcomes were postoperative pain scores and opioid consumption, expressed as oral morphine equivalents (OMEs), assessed through 96 postoperative hours. Secondary outcomes included time to mobilization and hospital length of stay. Descriptive statistics summarized postoperative outcomes, and Friedman repeated-measures analyses evaluated changes in pain scores and opioid utilization over time.

Results

Fifteen patients underwent posterior spinal fusion with surgeon-placed continuous ESP catheters. Pain scores remained predominantly within the mild-to-moderate range throughout the 96-hour postoperative period, with no significant change over time on Friedman analysis. Opioid utilization varied significantly across postoperative time points. Early mobilization was achieved in 80% of patients by postoperative day (POD) 1, 93% by POD 2, and 100% by POD 3.

Conclusions

Surgeon-placed continuous ESP catheters appear to be a technically feasible adjunct to multimodal analgesia following posterior spinal fusion surgery. In this pilot cohort, patients demonstrated stable postoperative pain trajectories and early mobilization; however, the absence of a comparator group

precludes conclusions regarding analgesic efficacy or opioid-sparing benefit. These findings provide preliminary data to inform future prospective controlled studies.

Introduction

Adequate postoperative pain control is a critical component of perioperative care, with important implications for patient recovery, complication rates, and opioid utilization. Posterior spinal fusion and other complex spine procedures are associated with substantial postoperative pain, often requiring high opioid doses during the early recovery period. Inadequate analgesia has been associated with delayed mobilization, prolonged hospitalization, increased postoperative complications, and persistent opioid use, highlighting the importance of effective opioid-sparing analgesic strategies within enhanced recovery after surgery (ERAS) pathways for spine surgery [1–11].

Regional anesthesia has become an increasingly important component of multimodal analgesia for spine surgery. The erector spinae plane (ESP) block is an interfascial plane technique that provides thoracic and lumbar analgesia through the spread of local anesthetic to adjacent neural structures. Owing to its technical simplicity and favorable safety profile, the ESP block has gained popularity as an adjunct for postoperative pain management following spine surgery [12–14].

Multiple randomized trials and recent reviews have demonstrated that ESP blocks may reduce postoperative pain scores, opioid consumption, and opioid-related adverse effects following lumbar spine surgery [12, 13, 15, 19]. However, findings remain inconsistent. Although several studies have reported improved analgesia and reduced opioid requirements, others have found little additional benefit when ESP blocks are incorporated into established multimodal analgesia and ERAS pathways [16]. Current evidence also suggests that injection level and local anesthetic volume have minimal influence on analgesic efficacy, but optimal techniques for continuous ESP catheter analgesia remain poorly defined [13, 17].

Continuous ESP catheter techniques have emerged as a strategy to extend analgesia beyond the duration of single-injection blocks. Surgically placed ESP catheters may offer additional advantages by allowing catheter placement under direct visualization during posterior spinal surgery, potentially improving catheter positioning while eliminating the need for a separate regional anesthesia procedure. Despite growing interest in continuous ESP analgesia, evidence regarding surgeon-placed ESP catheters remains limited, with existing literature consisting primarily of case reports, small case series, and heterogeneous perioperative protocols.

Patients with chronic pain undergoing posterior spinal fusion represent a particularly challenging population because pre-existing chronic pain, opioid exposure, and altered pain processing frequently increase postoperative analgesic requirements and complicate perioperative pain management. Despite these challenges, data evaluating continuous surgeon-placed ESP catheters specifically in chronic pain patients remain sparse.

The purpose of this retrospective observational pilot study was to evaluate postoperative analgesic outcomes associated with surgically placed continuous ESP catheters in chronic pain patients undergoing posterior spinal fusion surgery. Primary outcomes included postoperative pain scores and opioid consumption, expressed as oral morphine equivalents (OMEs), while secondary outcomes included time to mobilization and hospital length of stay. We hypothesized that surgeon-placed continuous ESP catheters would be associated with stable postoperative pain control, acceptable opioid utilization, and early postoperative mobilization.

Methods

Study Design and Patient Selection

This retrospective, single-center observational study was approved by the institutional review board, which granted a waiver of informed consent because of the retrospective study design. Adult patients who underwent posterior spinal fusion between January 2022 and January 2025 and received bilateral erector spinae plane (ESP) catheters for postoperative analgesia were identified through electronic medical record review. All enrolled patients met criteria for chronic pain, defined as documented pain persisting for at least 3 months that required ongoing pharmacologic management before surgery. Patients were included if they underwent posterior spinal fusion with intraoperative bilateral ESP catheter placement and had complete postoperative pain and opioid consumption data available. Patients were excluded for incomplete medical records, premature catheter removal before postoperative assessment, documented allergy to local anesthetics, infection at the planned catheter insertion site, coagulopathy, or trauma designation with multi-extremity injuries.

ESP Catheter Placement

During wound closure, bilateral ESP catheters were placed under direct surgical visualization by the neurosurgical team at the operative levels. Catheters were tunneled subcutaneously to separate skin exit sites and secured using Biopatch™, Steri-Strips™, and transparent occlusive dressings.

ESP Infusion Protocol

ESP Infusion Protocol

Following catheter placement, each bilateral ESP catheter was initially bolused intraoperatively with 20–30 mL of 0.25% bupivacaine. Cumulative local anesthetic dosing was individualized according to patient factors and maintained within accepted safety limits to minimize the risk of local anesthetic systemic toxicity (LAST). Postoperatively, 0.2% ropivacaine was administered as independent continuous bilateral infusions through each catheter using Alaris® infusion pumps at an initial infusion rate of 6–10 mL/h per catheter. Infusions were managed by the Acute Pain Service according to institutional protocols, with infusion rates adjusted based on analgesic response and clinical assessment. Patient-controlled

boluses were not available. Patients reporting severe pain despite continuous infusion were evaluated by the Acute Pain Service and, when clinically indicated, received clinician-administered local anesthetic boluses through the existing catheters or had their infusion rates increased.

Catheters were routinely removed at the end of postoperative day (POD) 4 after transition to an oral analgesic regimen. Catheter duration was extended when clinically indicated but did not exceed 7 postoperative days. Patients with prolonged catheter placement underwent daily evaluation by the Acute Pain Service, including catheter site inspection and monitoring for local and systemic signs of infection (erythema, drainage, fever, chills, and leukocytosis) in accordance with institutional protocols.

Multimodal Analgesic Management

All patients received standard of care multimodal analgesia consisting of scheduled acetaminophen, a muscle relaxant, a gabapentinoid, and opioid medications as needed. Additional clinician-directed adjuncts, including continuous ketamine infusions and intravenous hydromorphone patient-controlled analgesia (PCA), were administered when clinically indicated at the discretion of the Acute Pain Service and primary surgical team.

Data Collection

Demographic and perioperative variables collected through electronic medical record review included age, sex, surgical procedure, number of spinal levels fused, catheter duration, time to mobilization, and hospital length of stay. Postoperative opioid consumption was converted to oral morphine equivalents (OMEs) to standardize comparisons. Pain intensity was assessed using the 11-point Numeric Rating Scale (NRS; 0 = no pain, 10 = worst imaginable pain) in the postanesthesia care unit (PACU) and at 6, 12, 24, 48, 72, and 96 hours postoperatively.

The primary outcomes were postoperative pain scores and opioid consumption at each assessment time point. Secondary outcomes included time to mobilization, hospital length of stay, and catheter-related complications, including catheter dislodgement, infection, local anesthetic systemic toxicity, and neurologic complications.

Statistical Analysis

Descriptive statistics were used to summarize patient demographics, perioperative characteristics, postoperative pain scores, opioid consumption, and recovery outcomes. Continuous variables are presented as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), as appropriate based on data distribution. Categorical variables are presented as frequencies and percentages. Given the exploratory nature of this pilot study and the limited sample size, analyses were primarily descriptive. Because pain scores and opioid consumption consisted of repeated within-subject measurements with non-normal distributions, Friedman repeated-measures analyses were performed to evaluate temporal

changes across postoperative time points. Statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 28.0 (IBM Corp., Armonk, NY, USA). Statistical significance was defined as a two-sided $p < 0.05$.

Results

Patient Characteristics and ESP Catheter Outcomes

A total of 15 patients undergoing posterior spinal fusion surgery received surgically placed bilateral ESP catheters for postoperative analgesia. The cohort had a mean age of 70.2 ± 12.7 years and was predominantly female (86.7%). Catheter placement included six lumbar, one cervical, and eight thoracic levels. Mean catheter duration was 4.79 ± 1.72 days, with a median duration of 4.5 days. Three catheters (20%) were inadvertently dislodged during physical therapy and removed prematurely. One patient developed tinnitus concerning local anesthetic-related adverse effects; the infusion was temporarily paused and subsequently resumed at a lower rate. No cardiovascular, respiratory, hemodynamic, infectious, or neurologic complications were identified.

Postoperative Pain Scores

Postoperative pain was assessed using the 11-point Numeric Rating Scale (NRS; 0 = no pain, 10 = worst imaginable pain) at predefined postoperative time points. Pain scores remained predominantly within the mild-to-moderate range throughout the 96-hour observation period.

In the PACU, 9 patients (60.0%) reported mild pain, 4 (26.7%) reported moderate pain, and 2 (13.3%) reported severe pain (NRS = 10). Both patients with severe pain received rescue analgesia with either clinician-administered local anesthetic bolus or as-needed opioid therapy.

Across subsequent assessments, moderate pain was the most frequently reported category, ranging from 26.7% to 46.7% of patients, while mild pain was reported in 20.0% to 46.7% of patients. Severe pain remained uncommon, occurring in 13.3% of patients at 6 hours, 6.7% at 12 and 24 hours, 0% at 48 hours, 20.0% at 72 hours, and 13.3% at 96 hours (Table 1).

Mean pain scores ranged from 3.53 ± 4.69 in the PACU to a peak of 5.43 ± 3.52 at 12 hours and decreased to 4.13 ± 2.92 at 96 hours. Median pain scores increased from 0 (IQR 0–8) in the PACU to 7.5 (IQR 1–8) at 12 hours and remained between 4 and 5 through 96 hours (Table 1).

Friedman repeated-measures analysis demonstrated no significant differences in pain scores across postoperative time points ($\chi^2 = 3.84$, $p = 0.572$). Kendall's W was 0.05, indicating minimal variation in pain scores over time.

Table 1
Postoperative Pain Scores and Severity Distribution Following Surgically Placed ESP Catheters

Time Point	N	Mean NRS $\pm$ SD	Median NRS (IQR)	No Pain (NRS 0), n (%)	Mild Pain (NRS 1–3), n (%)	Moderate Pain (NRS 4–6), n (%)	Severe Pain (NRS 7–10), n (%)
PACU	15	3.53 $\pm$ 4.69	0 (0–8)	0 (0.0)	9 (60.0)	4 (26.7)	2 (13.3)
6 hours	15	3.93 $\pm$ 4.01	3 (0–8)	5 (33.3)	3 (20.0)	5 (33.3)	2 (13.3)
12 hours	14*	5.43 $\pm$ 3.52	7.5 (1–8)	4 (26.7)	3 (20.0)	7 (46.7)	1 (6.7)
24 hours	15	4.27 $\pm$ 3.13	4 (1–7)	3 (20.0)	7 (46.7)	4 (26.7)	1 (6.7)
48 hours	15	4.27 $\pm$ 2.94	5 (2–6)	2 (13.3)	7 (46.7)	6 (40.0)	0 (0.0)
72 hours	15	4.80 $\pm$ 3.38	4 (2–7)	0 (0.0)	5 (33.3)	7 (46.7)	3 (20.0)
96 hours	15	4.13 $\pm$ 2.92	4 (2–7)	0 (0.0)	7 (46.7)	6 (40.0)	2 (13.3)

*This dataset contained one missing value, which was excluded.

Opioid Consumption

Postoperative opioid consumption is summarized in Table 2. The proportion of patients receiving opioids remained relatively stable during the first 48 postoperative hours, with 53.3–60.0% of patients requiring opioids, increasing to 80.0% at both 72 and 96 hours. Median OME consumption was lowest at 12 hours (9.0 mg; IQR 0–15.0 mg) and highest at 96 hours (30.0 mg; IQR 7.5–52.5 mg). Mean OME consumption ranged from 9.1 $\pm$ 10.3 mg at 12 hours to 36.8 $\pm$ 42.0 mg at 96 hours. Substantial interpatient variability was observed, with cumulative 96-hour opioid consumption ranging from 10 to 501.5 mg (median 120 mg; IQR 60–165 mg). Friedman repeated-measures analysis demonstrated significant variation in opioid consumption across postoperative time points ($\chi^2 = 12.71$, $p = 0.026$). Kendall's W was 0.18, indicating a small-to-moderate effect size.

Table 2
Postoperative opioid consumption (oral morphine equivalents, OME).

Time point	Patients receiving opioids, n (%)	Median OME (IQR), mg	Mean $\pm$ SD, mg	Range, mg
6 hours	9 (60.0%)	24.0 (0–41.2)	22.6 $\pm$ 25.3	0–76.0
12 hours	9 (60.0%)	9.0 (0–15.0)	9.1 $\pm$ 10.3	0–33.0
24 hours	8 (53.3%)	15.0 (0–33.0)	13.9 $\pm$ 15.8	0–39.0
48 hours	9 (60.0%)	15.0 (0–25.5)	21.7 $\pm$ 37.1	0–147.0
72 hours	12 (80.0%)	24.0 (7.5–35.0)	25.6 $\pm$ 27.0	0–105.0
96 hours	12 (80.0%)	30.0 (7.5–52.5)	36.8 $\pm$ 42.0	0–138.0

Functional Recovery and Length of Stay

Median hospital length of stay was 8 days (IQR 5–15 days), with a mean duration of 9.6 ± 5.3 days and a range of 3–17 days.

Early postoperative mobilization was achieved in the majority of patients. Twelve patients (80.0%) mobilized on postoperative day (POD) 1, 14 patients (93.3%) by POD 2, and all patients by POD 3. Median time to mobilization was POD 1 (IQR POD 1–POD 1).

Discussion

Continuous erector spinae plane (ESP) catheters have emerged as a potential strategy to extend postoperative analgesia after spine surgery; however, evidence regarding surgically placed continuous catheters remains limited. In this retrospective pilot study, surgeon-placed ESP catheters were successfully incorporated into posterior spinal fusion procedures and were associated with stable postoperative pain trajectories, limited catheter-related complications, and early mobilization. Catheters remained in place for a median of 4.5 days, providing continuous analgesic delivery during the early postoperative period when pain burden and rehabilitation demands are greatest. These findings provide preliminary feasibility data and establish benchmarks to inform future prospective comparative studies.

A primary finding of this study was the operational feasibility of surgeon-placed ESP catheters. Placement under direct surgical visualization eliminates the need for a separate preoperative regional anesthesia procedure and may facilitate integration into existing spine surgery workflows. The primary technical limitation was inadvertent catheter dislodgement during physical therapy, which occurred in three patients (20%). Although no adverse clinical consequences were observed, premature removal may reduce the intended duration of analgesia. Future investigations should evaluate catheter securement strategies, including optimized tunneling techniques, dressings, and exit-site placement to improve catheter durability while maintaining patient mobility.

The safety profile observed in this cohort was favorable. No infectious, cardiovascular, respiratory, hemodynamic, or neurologic complications were identified. One patient experienced transient tinnitus concerning for local anesthetic-related toxicity that resolved after temporarily discontinuing the infusion and restarting at a reduced rate. Although the sample size limits definitive safety conclusions, these findings support continued evaluation of surgeon-placed ESP catheters in larger populations.

Postoperative pain scores remained predominantly within the mild-to-moderate range throughout the 96-hour observation period, without significant variation over time. Severe pain episodes were uncommon and were managed with rescue analgesia. However, the absence of a comparator group prevents determination of analgesic efficacy. The observed stable pain trajectory during increasing mobilization and rehabilitation suggests that acceptable analgesia was maintained while catheters remained in place. These findings are consistent with prior studies demonstrating potential analgesic benefits of ESP blocks in spine surgery; however, most previous investigations have evaluated ultrasound-guided single-injection techniques rather than continuous surgeon-placed catheters.

An important observation was the discordance between pain scores and opioid consumption. Although pain scores remained relatively stable, opioid utilization increased during the later postoperative period, with greater opioid requirements observed at 72 and 96 hours. This pattern likely reflects the complexity of recovery following major spine surgery, including increased physical activity, transition between intravenous and oral analgesics, and patient-specific factors rather than inadequate analgesia alone. Pain scores and opioid consumption should therefore be interpreted as complementary outcomes when evaluating postoperative analgesic strategies.

This distinction is particularly relevant because the present cohort consisted exclusively of chronic pain patients undergoing complex posterior spinal fusion. Unlike several prior ESP studies involving relatively opioid-naïve populations, these patients frequently have baseline opioid exposure, altered pain processing, and increased risk for opioid tolerance. Consistent with this complexity, opioid consumption demonstrated substantial interpatient variability, with cumulative OME requirements ranging from 10 to more than 500 mg. These findings highlight the importance of individualized multimodal analgesic approaches and suggest that future studies should identify patient characteristics associated with the greatest potential benefit from regional analgesic techniques.

The findings should be interpreted within the context of the broader ESP literature. Randomized trials have demonstrated improved early postoperative analgesia and reduced opioid consumption following ultrasound-guided ESP blocks in lumbar spine procedures, whereas other studies have failed to demonstrate additional opioid-sparing benefit when ESP blocks were added to optimized ERAS pathways [12, 15, 16]. These differences suggest that the clinical impact of ESP techniques may depend on patient selection, surgical complexity, and the surrounding multimodal analgesic regimen. The present study cannot determine whether surgeon-placed ESP catheters reduce opioid consumption; however, it provides important feasibility data supporting further comparative evaluation.

Early mobilization is a central goal of ERAS pathways. In this cohort, 80% of patients mobilized on postoperative day (POD) 1, more than 90% by POD 2, and all patients by POD 3. Although causality cannot be attributed to ESP catheter use, these findings demonstrate that continuous catheter analgesia can be incorporated without apparent interference with rehabilitation goals. Intraoperative catheter placement may offer logistical advantages by allowing analgesic coverage while avoiding an additional regional anesthesia procedure.

Several limitations should be considered. The retrospective single-center design introduces potential selection bias, information bias, and residual confounding. The small sample size limits statistical precision and generalizability, and the absence of a control group prevents conclusions regarding comparative efficacy. Additionally, variability in opioid prescribing, baseline opioid exposure, multimodal analgesic regimens, and rehabilitation protocols may have influenced outcomes.

Despite these limitations, this study provides several important contributions. To our knowledge, this is one of only a few published studies evaluating surgeon-placed continuous ESP catheters following posterior spinal fusion surgery, extending the existing literature beyond ultrasound-guided single-shot ESP techniques. In addition to longitudinal pain assessment and standardized opioid conversion, this study evaluated implementation outcomes including catheter duration, premature dislodgement, catheter-related adverse events, and functional recovery. These findings suggest that surgeon-directed ESP catheter placement is technically feasible and may represent an approach that can be incorporated into spine surgery workflows.

Future prospective studies should compare surgeon-placed ESP catheters with ultrasound-guided techniques and contemporary multimodal analgesic pathways using standardized protocols. Important outcomes should include postoperative pain, opioid consumption, patient-reported outcomes, opioid-related adverse events, catheter durability, functional recovery, cost-effectiveness, and integration within ERAS pathways to determine whether the logistical advantages of this technique translate into meaningful clinical benefit.

Conclusion

Surgeon-placed continuous erector spinae plane (ESP) catheters appear to be a technically feasible adjunct to multimodal analgesia following posterior spinal fusion surgery. In this pilot cohort of chronic pain patients, continuous ESP catheter use demonstrated stable postoperative pain trajectories, a favorable safety profile, and early mobilization. However, the absence of a comparator group limits conclusions regarding analgesic efficacy or opioid-sparing effects. These findings provide preliminary feasibility and outcome benchmarks to guide future prospective studies evaluating the effectiveness, safety, and clinical implementation of continuous surgeon-placed ESP catheter techniques.

Declarations

Author Contribution

JD: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Writing - Original Draft, Writing - Review & Editing; AK: Supervision, Validation, Writing - Original Draft, Writing - Review & Editing; JC: Supervision, Validation, Writing - Original Draft, Writing - Review & Editing; GG: Data curation, Methodology, Writing - Original Draft, Writing - Review & Editing; JW: Data curation, Methodology, Writing - Original Draft, Writing - Review & Editing; NK: Writing - Original Draft, Writing - Review & Editing; PH: Conceptualization, Investigation, Project administration, Supervision, Validation, Writing - Original Draft, Writing - Review & Editing; MR: Investigation, Project administration, Supervision, Validation, Writing - Original Draft, Writing - Review & Editing; EH: Supervision, Validation, Writing - Original Draft, Writing - Review & Editing; AC: Conceptualization, Project administration, Supervision, Validation, Writing - Original Draft, Writing - Review & Editing; CA: Supervision, Validation, Writing - Original Draft, Writing - Review & Editing.

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