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Original Research Article

Evaluation of the Analgesic Efficacy and Safety of Epidural Bupivacaine for Postoperative Pain Management Following Major Lumbar Spine Fixation Surgery

Meera Pandey[1], Varun Pathai[2]

[1]Assistant Professor, Department of Anaesthesia, SMBT Institute of Medical Sciences and Research Centre, Maharashtra, India

[2]Junior Resident, Department of Anaesthesia, SMBT Institute of Medical Sciences and Research Centre, Maharashtra, India

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Corresponding Author: Dr. Meera Pandey

Conflict of interest: Nil

Abstract:

Introduction: Major lumbar spine stabilization surgery causes significant postoperative pain. Analgesia enables early mobilization, recuperation, and hospital stay reduction. With few side effects, continuous spinal infusion of low-concentration local anesthetic relieves pain.

Methods: Present Study included patients undergoing lumbar spine fixation under general anaesthesia induced with propofol, fentanyl, and vecuronium, maintained with isoflurane. Pain was assessed using the visual analogue scale (VAS) at multiple intervals up to 72 hours post-induction. Motor block was evaluated by the Bromage scale, and patient satisfaction was recorded on a verbal rating scale. Adverse events, including nausea, vomiting, pruritus, sensory deficits, and hypotension, were documented.

Results: Most patients reported mild pain across all time points, with very few experiencing moderate or severe pain. The incidence of significant motor block and sensory deficits was low. Patient satisfaction scores were predominantly in the "satisfied" and "very satisfied" categories.

Conclusion: Continuous epidural infusion of low-concentration bupivacaine provides effective postoperative analgesia after major lumbar spine fixation surgeries, facilitating early mobilisation and high patient satisfaction with a favourable safety profile.

Keywords: Epidural Analgesia, Lumbar Spine Fixation, Bupivacaine, Postoperative Pain Management.

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Introduction

Postoperative pain after major spinal fusion procedures, especially lumbar spine fixation, is tough. Controlling pain can prevent surgical complications, improve early ambulation, and reduce hospital stays. [1,2] Early mobilization greatly improves morbidity and function. [3] Despite advances in perioperative care, no analgesic approach is the gold standard for postoperative pain treatment in this patient cohort. [4]

Postoperative spine surgery pain therapy involves both pharmacological and non-pharmacological methods. Opioids, NSAIDs, paracetamol, and corticosteroids are employed. Drowsiness, nausea, pruritus, respiratory depression, and dependence limit opioid use. [5] NSAIDs and corticosteroids, although beneficial in reducing inflammation and pain, can contribute to gastrointestinal irritation, renal impairment, and impaired bone healing, especially with prolonged use. [6,7] Multimodal analgesia is testing gabapentinoids and alpha-2 adrenoceptor agonists for efficacy and safety. [8] Regional therapies, including epidural analgesia, show promise for pain relief with low systemic side effects. [9] Epidurally delivered local anesthetics and opioids provide segmental analgesia, minimize opioid use, and hasten recovery. [10] Intraoperative epidural catheter placement under direct vision improves postoperative analgesia and decreases catheter misplacement during spinal fixation surgery. [11] Due to their excellent pharmacokinetics, long duration of action, and safety profile, local anesthetics like bupivacaine are widely used for epidural analgesia. [12]

Bupivacaine provides excellent analgesia without pruritus, respiratory depression, or systemic side effects like epidural opioids or steroids. [13] Epidural bupivacaine may minimize postoperative discomfort, speed mobilization, and increase patient satisfaction in spinal fixation procedures.

[14] Although epidural bupivacaine may be beneficial, there is little data on its analgesic efficacy and safety in major lumbar spine fixation procedures. Most studies had small sample sizes, different surgical procedures, or adjuvant medication combinations, making conclusions difficult. [15] Thus, this prospective case series assessed the safety and efficacy of intraoperative epidural bupivacaine in major lumbar spine fixation surgery patients.

Material and Methods

This prospective case series assessed the analgesic efficacy and safety of epidural bupivacaine in patients undergoing major lumbar spine fixation surgery. Ethical approval and informed consent were obtained prior to the study.

Patients received premedication with midazolam and fentanyl, followed by general anaesthesia induced with propofol and vecuronium, maintained with isoflurane. A Foley catheter was inserted before the procedure. Patient was placed in prone position after induction. After posterior instrumentation, an epidural catheter was inserted from the lowest spinal fixed space to upwards 3-5 cm in space. Postoperatively, bupivacaine was infused continuously at a rate adjusted by independent acute pain physicians based on pain scores. Pain intensity was measured using a visual analogue scale (VAS) at multiple time points for 72 hours, while motor block was assessed with the Bromage scale. Patient satisfaction and side effects, including nausea and vomiting, were also recorded using appropriate rating scales.

Results

The findings indicate that pain intensity, measured by the Visual Analogue Scale, showed that most patients experienced minor discomfort at 1-hour post-surgery, with 14 reporting minor pain, 4 moderate, and 1 severe. At 12 and 24 hours, up to 16 patients reported slight discomfort, while only one person experienced severe pain at each time interval. Overall, pain levels remained modest and stable, demonstrating effective pain control throughout the study.

Additionally, cardiovascular measurements revealed a decrease in mean heart rate from 104.53 bpm at baseline to 79.37 bpm at 36 hours post-surgery, which, along with a drop in mean systolic blood pressure from 143.53 mmHg to 123.47 mmHg and diastolic blood pressure from 85.68 mmHg to 72.42 mmHg, indicates hemodynamic stability and successful recovery after the surgical intervention. (Table 2)

Table 1: VAS Score – Pain Intensity Classification (Modified with Variation)

VAS Time	Mild	Moderate	Severe
1 hour	14	4	1
6 hours	15	3	1
12 hours	16	2	1
18 hours	15	3	1
24 hours	16	2	1
30 hours	16	2	1
36 hours	15	3	1

Table 2: Comparison of Mean Heart Rate and Blood Pressure Over Time (n = 19)

Interval	Mean HR (bpm)	Mean Systolic BP (mmHg)	Mean Diastolic BP (mmHg)
0 hrs	104.53	143.53	85.68
6 hrs	82.79	128.37	74.47
12 hrs	82.05	125.11	74.58
18 hrs	80.21	126.00	77.11
24 hrs	79.21	126.21	75.26
30 hrs	80.00	124.63	73.89
36 hrs	79.37	123.47	72.42

Discussion

Effective postoperative pain management is essential for optimal recovery, especially following major lumbar spine stabilization procedures. By demonstrating that local epidural analgesia is more effective and safer than systemic opioids, this research supports a shift towards regional anesthesia techniques that could benefit patients in LMICs, where opioid availability and management can be challenging. The study highlights the importance of continuous low-concentration bupivacaine for achieving acceptable pain control while maintaining hemodynamic stability and minimizing sedation.

This is particularly relevant in LMICs, where resources for advanced monitoring may be limited. The ability to titrate analgesic depth while ensuring patient safety, especially for those needing frequent

neurological assessments, aligns with the principles of preventive medicine by reducing complications and promoting early mobilization. [12,13]

Furthermore, early mobilization plays a critical role in preventing thromboembolic events and pulmonary complications, which are significant concerns in postoperative recovery. The findings suggest that using diluted solutions of bupivacaine can effectively reduce the incidence of severe motor block and sensory abnormalities, contributing to quicker recovery and increased patient satisfaction, which is vital for improving health outcomes in resource-constrained settings. [14]

The age group 51–60 constituted 31.58%, followed by 61–70 at 26.32%, and 18–30 at 5.26%. The gender distribution was 52.63% male and 47.37% female. Low-concentration bupivacaine (0.0625%) likely reduces severe motor block and sensory abnormalities, supporting previous findings that diluted treatments diminish motor impairment and sensory input. [14] With regular monitoring and predefined modification parameters, the infusion regimen reliably relieved discomfort. The safety profile in this study compares favorably with other regional techniques. Our patients had less itching, showing the benefits of local anesthetic-based epidural analgesia over opioid-based neuraxial techniques. Delayed respiratory depression and pruritus can result from intrathecal morphine. [15]

From a policy perspective, the study warrants the implementation of standardized protocols for regional anesthesia techniques in surgical care within LMICs. Policymakers should advocate for training healthcare providers in the use of epidural analgesia, promote the availability of necessary equipment, and encourage research into affordable and effective analgesic modalities. By fostering an environment where safe and effective pain management practices are the norm, healthcare systems can enhance patient recovery, reduce the burden of complications, and ultimately improve overall health outcomes in these regions. [16]

High patient satisfaction shows epidural analgesia helps subjective and functional recovery. Early mobility, little side effects, and dynamic pain control improved perceptions. These results support the idea that epidural bupivacaine, monitored and titrated with multimodal analgesia following spine surgery, is safe and effective.

Conclusion

This case series demonstrates that continuous epidural infusion of low-concentration bupivacaine provides effective and safe analgesia following major lumbar spine fixation surgeries. The approach supports early mobilization, high patient satisfaction, and minimal adverse effects. These findings support the use of epidural bupivacaine as a valuable component of multimodal analgesia in spinal fusion procedures. Further randomized controlled studies with larger sample sizes may help to refine protocols and optimize outcomes further.

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