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RESEARCH ARTICLE OPEN ACCESS

Comparison of intra-operative and postoperative outcomes after general versus spinal anaesthesia in lumbar spine surgeries: A prospective comparative study

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Abstract
Objective: To compare intraoperative blood loss and early postoperative outcomes in elective lumbar spine surgery under spinal anaesthesia (SA) versus general anaesthesia (GA).
Methods: This prospective comparative study enrolled 60 adults (ASA I–II) undergoing one- or two-level transpedicular lumbar stabilisation in 2022. Patients were allocated to GA (n=30) or SA (n=30) based on anaesthesiologist-surgeon consensus. Mean arterial pressure was maintained at 60–80 mmHg. The primary outcome was intraoperative blood loss (Moore method). Secondary outcomes included haemodynamic changes, postoperative nausea and vomiting (PONV), analgesia, satisfaction, and complications.
Results: Groups were comparable at baseline. Surgery duration was similar. Intraoperative blood loss was significantly higher with GA ($p<0.05$). Mean heart-rate change from baseline was greater with GA (7±2 vs 3±1 bpm; $p=0.039$), as was haemoglobin decline (8.4% vs 3.6%; $p=0.018$). Complication rates and PONV were similar. Surgeon satisfaction (100.0% vs 83.3%; $p=0.031$) and patient satisfaction (93.3% vs 73.3%; $p=0.041$) favoured SA. PACU analgesia was comparable, but at 24 hours, eight GA patients required additional analgesia versus none in the SA group ($p=0.003$).
Conclusion: Spinal anaesthesia was associated with significantly lower intraoperative blood loss, better haemodynamic stability, higher satisfaction, and reduced 24-hour analgesic requirements compared to GA, with mean arterial pressure controlled. SA appears to be a feasible alternative for selected lumbar procedures; larger randomised trials are warranted.

Keywords: spinal anaesthesia; general anaesthesia; lumbar spine; blood loss; perioperative outcomes

Plain English Summary

In 60 adults having planned lumbar spine surgery, we compared two anaesthesia approaches: spinal (a regional block) and general (a full anaesthetic with breathing tube). When careful blood-pressure targets were kept during surgery, patients who had spinal anaesthesia lost less blood, had smaller changes in heart rate, and required fewer pain medicines 24 hours after surgery. Both surgeons and patients reported higher satisfaction with spinal anaesthesia. These findings suggest spinal anaesthesia can be a good option for some lumbar spine operations, but larger trials are needed to be certain.

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Introduction

Degenerative lumbar spine disease remains a significant contributor to global morbidity, with lumbar fusion and stabilisation procedures increasing steadily over the past two decades (1, 2). Factors such as population ageing, sedentary lifestyles, and advances in diagnostic imaging have contributed to the rising number of lumbar spine surgeries performed worldwide (3). The choice of anaesthetic technique for these procedures is of considerable clinical importance because it influences intraoperative haemodynamic, surgical field clarity, perioperative blood loss, postoperative pain control, recovery trajectory, and overall satisfaction of both patients and surgeons (4, 5, 6). General anaesthesia (GA) has historically been the default approach for lumbar spine surgery due to the ability to secure airway control, provide stable anaesthetic depth, and accommodate long or complex procedures. Nonetheless, GA has recognised drawbacks, including greater blood loss linked to increased venous pressure in the epidural plexus, higher postoperative opioid consumption, nausea, and delayed recovery in some patients (7, 8). Conversely, spinal anaesthesia (SA) offers potential advantages such as reduced intraoperative blood loss, improved hemodynamic control, lower postoperative analgesic requirements, lower incidence of postoperative nausea and vomiting (PONV), and quicker ambulation (9, 10, 11). Recent systematic reviews and meta-analyses have supported these potential benefits; however, evidence remains inconsistent due to variability in study methods, patient selection, and anaesthetic protocols (12, 13).

In addition, the physiologic mechanisms underlying differences between SA and GA are increasingly recognised. Reduced intrathoracic pressure during spontaneous breathing under SA, decreased venous congestion in the epidural plexus, and attenuation of the sympathetic response may all contribute to a cleaner surgical field and reduced blood loss (14, 15). Despite these potential advantages, concerns regarding the suitability of SA for multilevel procedures, patient anxiety, and the risk of intraoperative conversion to GA persist among some anaesthesiologists and surgeons (16, 17).

Given the existing gaps in evidence, particularly from low-resource settings where SA may offer practical advantages, this prospective comparative study aimed to evaluate intraoperative blood loss and postoperative outcomes in patients undergoing single- or two-level lumbar spine stabilisation under GA or SA. By standardising mean arterial pressure (MAP) targets and carefully documenting hemodynamic and clinical outcomes, this study provides context-specific evidence to inform anaesthetic choice in lumbar spine surgery.

Materials and Methods

Study design and participants

This prospective, comparative observational study was conducted between January and December 2022. Sixty adult patients (18–70 years) with degenerative lumbar spine disease who were scheduled for elective transpedicular stabilisation (one or two segments) and classified ASA I–II were consecutively recruited. Patients with spine trauma, neoplasm, coagulopathy, severe spinal stenosis preventing safe neuraxial block, history of seizures, intracranial hypertension, or those who required intraoperative conversion to a different anaesthesia modality or had massive intraoperative bleeding were excluded.

Allocation

Patients were allocated to receive GA or SA based on the joint decision of the attending anaesthesiologist and the operating surgeon, considering patient factors and procedural considerations. Because allocation was not randomised, we describe this as a prospective comparative (observational) study; this is acknowledged as a limitation in the Discussion.

Anaesthetic and intraoperative management

GA: Standard induction and maintenance according to institutional practice with tracheal intubation. SA: Single-shot spinal block at an appropriate lumbar level to achieve surgical anaesthesia. All anaesthetic drugs and doses were given according to standard guidelines and at the discretion of the attending anaesthesiologist.

In all patients, the target mean arterial pressure (MAP) was 60–80 mmHg. Hemodynamic variables (HR, MAP, SpO_2) were recorded every 15 minutes intraoperatively. When MAP fell below 60 mmHg or exceeded 80 mmHg, the anaesthesiologist intervened with fluids and/or vasoactive drugs as clinically indicated. No patient received a blood transfusion during the study.

Outcomes and measurements

Primary outcome

Intraoperative blood loss was measured using the Moore method (suction canister volume adjusted for irrigation fluid + net sponge weight).

Secondary outcomes

Intraoperative heart-rate change from baseline, haemoglobin level change (preoperative and 24 h postoperative), duration of surgery, PONV, analgesic requirement in PACU and at 24 hours, surgeon and patient satisfaction (binary satisfied/dissatisfied recorded at 24 h), and any complications.

Sample size

A convenience sample of 60 patients (30 per group) was used. No formal a priori power calculation was available; this is discussed in the Limitations section.

Statistical analysis

Analyses were performed using SPSS v27. Normality was assessed with the Kolmogorov–Smirnov test. Continuous variables with normal distribution are summarised as mean ± SD and were compared using Student's t-test; non-normal data were compared with the Mann–Whitney U test. Categorical variables were compared with chi-square or Fisher's exact test as appropriate. Correlations were assessed with Pearson's r. Two-sided $p < 0.05$ was considered statistically significant.

Results

Participants and baseline characteristics

Sixty patients were enrolled and allocated to the GA (n = 30) or SA (n = 30) groups. Baseline demographic and clinical characteristics were similar between groups (Table 1). Age distribution was comparable: ≤30 years (GA 9/30 [30.0%] vs SA 11/30 [36.7%]), 31–40 years (GA 13/30 [43.3%] vs SA 12/30 [40.0%]), and >40 years (GA 8/30 [26.7%] vs SA 7/30 [23.3%]). Sex distribution, ASA class and BMI categories did not differ significantly between groups. Mean age was 34.6 ± 7.2 years in the GA group and 34.3 ± 8.1 years in the SA group (Table 1).

Table 1: Baseline characteristics of the studied groups

Variable	GA (n = 30)	SA (n = 30)	p-value*
Age, mean ± SD (years)	34.6 ± 7.2	34.3 ± 8.1	—
Age category, n (%)			0.857
≤ 30 years	9 (30.0)	11 (36.7)	
31–40 years	13 (43.3)	12 (40.0)	
> 40 years	8 (26.7)	7 (23.3)	
Sex, n (%)			1
Male	18 (60.0)	18 (60.0)	
Female	12 (40.0)	12 (40.0)	
ASA class, n (%)			1
I	16 (53.3)	17 (56.7)	
II	14 (46.7)	13 (43.3)	
BMI category, n (%)			0.782
Normal	10 (33.3)	9 (30.0)	
Overweight	12 (40.0)	14 (46.7)	
Obese	8 (26.7)	7 (23.3)	

*Chi-square or Fisher's exact test for categorical variables

Intraoperative findings

Operative times were similar between groups (Figure 1). Median/mean duration of surgery did not differ significantly between GA and SA ($p > 0.05$), indicating comparable procedural complexity across groups

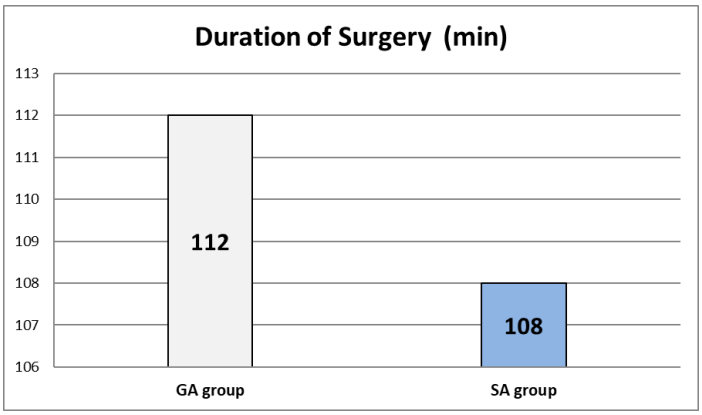


Figure 1: Duration of surgery in GA vs SA groups (n = 30 per group). p = 0.675

Intraoperative haemodynamic and blood loss were assessed in all patients. Heart rate at induction was similar (GA 83 ± 10 vs SA 84 ± 13, p = 0.691), but at 30 and 60 minutes, the GA group exhibited higher heart rates (30 min: 86 ± 9 vs 79 ± 7, p = 0.014; 60 min: 89 ± 11 vs 80 ± 6, p = 0.022). The mean intraoperative heart-rate change from baseline was significantly larger in the GA group (7 ± 2 beats/min) compared with the SA group (3 ± 1 beats/min), p = 0.039 (Table 2).

Table 2: Blood loss and heart rate changes

Parameter	GA (mean ± SD)	SA (mean ± SD)	p-value*
Heart rate — induction (beats/min)	83 ± 10	84 ± 13	0.691
Heart rate — 30 min (beats/min)	86 ± 9	79 ± 7	0.014
Heart rate — 60 min (beats/min)	89 ± 11	80 ± 6	0.022
Heart rate — 90 min (beats/min)	90 ± 8	81 ± 9	0.711
Mean heart-rate change (beats/min)	7 ± 2	3 ± 1	0.039
Hb % change (preop → 24 h)	8.40%	3.60%	GA: 0.018; SA: 0.201

*Student's t-test used for normally distributed variables

Total intraoperative blood loss measured by the Moore method was significantly greater in the GA group than in the SA group (Figure 2). Correspondingly, the percentage haemoglobin change from baseline to 24 hours post-op was higher in the GA group (8.40%, p = 0.018) versus the SA group (3.60%, p = 0.201) (Table 2).

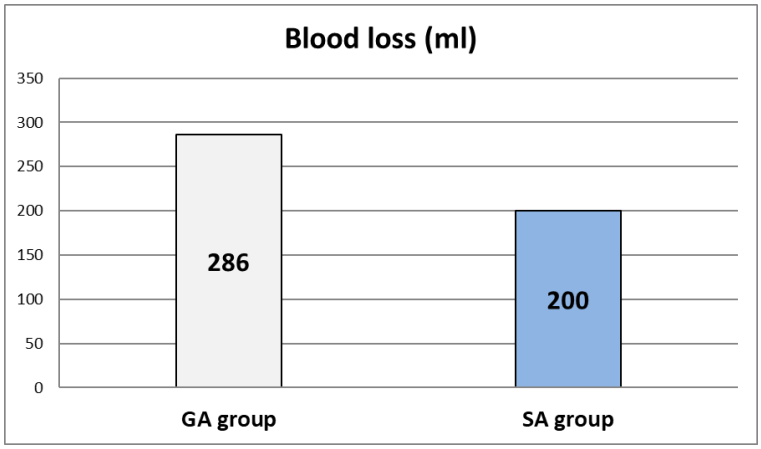


Figure 2: Intraoperative blood loss (Moore method) in GA vs SA groups (n = 30 per group). p = 0.023

Postoperative outcomes

Postoperative complications were rare and did not differ between groups (GA 2/30 [6.7%] vs SA 1/30 [3.3%], p = 0.891). Surgeon satisfaction was significantly higher following procedures performed under SA (SA 30/30 [100%] vs GA 25/30 [83.3%]; p = 0.031), and patient satisfaction was also greater in the SA group (SA 28/30 [93.3%] vs GA 22/30 [73.3%]; p = 0.041). Rates of postoperative nausea and vomiting (PONV) were numerically lower in SA (6.7% vs 20.0%) but did not reach statistical significance (p = 0.254) (Table 3).

Table 3: Postoperative outcomes (complications, PONV, satisfaction)

Outcome	GA (n = 30)	SA (n = 30)	p-value*
Complications — yes, n (%)	2 (6.7)	1 (3.3)	0.891
Surgeon satisfied — yes, n (%)	25 (83.3)	30 (100.0)	0.031
Patient satisfied — yes, n (%)	22 (73.3)	28 (93.3)	0.041
PONV — yes, n (%)	6 (20.0)	2 (6.7)	0.254

*Chi-square or Fisher's exact test as appropriate

Analgesic needs in the immediate PACU were high in both groups (GA 27/30 [90.0%] vs SA 30/30 [100%], p = 0.118). By 24 hours postoperatively, however, 8 patients in the GA group (26.7%) required additional analgesia compared with none in the SA group (0%; p = 0.0031) (Table 4).

Table 4: Analgesic requirements in PACU and at 24 hours

Time point	GA (n)	GA (%)	SA (n)	SA (%)	p-value*
In PACU	27	90	30	100	0.118
After 24 hours	8	26.7	0	0	0.0031

Discussion

In this prospective comparative study, spinal anaesthesia was associated with lower intraoperative blood loss, smaller intraoperative heart-rate changes, higher surgeon and patient satisfaction, and reduced analgesic needs at 24 hours compared with general anaesthesia when MAP was actively maintained between 60 and 80 mmHg. These findings are consistent with earlier reports demonstrating that regional techniques may offer haemodynamic advantages and improved perioperative stability in lumbar spine surgery (4, 5, 7, 8).

Our results also align with several prior studies suggesting that regional anaesthesia can reduce intraoperative bleeding and postoperative opioid consumption, likely through mechanisms such as sympathetic blockade, reduced venous pressure, and attenuation of the surgical stress response (11, 12, 13, 14). The physiologic basis for these differences has been described in the literature, including reduced intrathoracic pressure during spontaneous ventilation under spinal anaesthesia, less venous congestion in the epidural venous plexus, and blunted catecholamine release (14,15). These mechanisms support more stable operative conditions, which may contribute to lower blood loss and improved surgical field visibility.

Variability across published studies may be explained by heterogeneity in general anaesthetic techniques (e.g., intravenous versus inhalational agents), which have differing effects on peripheral vasodilation and venous pooling.10 Differences in the use of deliberate hypotension, administration of local haemostatic agents such as tranexamic acid, or differences in patient selection and comorbidities may also influence observed outcomes across settings (3, 7, 11).

The higher surgeon and patient satisfaction observed after spinal anaesthesia in our cohort further suggests benefits beyond purely physiological parameters. Prior literature similarly reports enhanced patient comfort, improved early postoperative pain control, and earlier return to baseline function when regional techniques are used in appropriately selected lumbar spine procedures (6, 8, 16, 17). The clearer operative field and more predictable haemodynamic under spinal anaesthesia may also enhance surgeon satisfaction (7).

Strengths and limitations

Strengths include prospective data collection and standardised MAP targets. This study has several important limitations. Although the data were collected prospectively, the allocation to either spinal or general anaesthesia was not randomised. This introduces the possibility of selection bias, as clinical judgment by the anaesthesiologist or surgeon may have influenced group assignment. In addition, the work was carried out in a single centre, and all procedures were performed by the

same surgeon, which may limit the generalizability of the findings to other settings or surgical practices.
The relatively modest sample size, combined with the absence of a formal a priori power calculation, means that some differences between groups may have gone undetected. Furthermore, the estimation of blood loss using the Moore method, while widely used, remains an indirect measure and is subject to measurement variability. Finally, there was some heterogeneity in the anaesthetic techniques used, including the choice of agents and specific intraoperative management decisions, which may have influenced outcomes despite efforts to maintain consistent mean arterial pressure targets.

Clinical implications and future research
For selected elective one- to two-level lumbar stabilisation procedures, spinal anaesthesia is a feasible alternative to general anaesthesia and may offer advantages in terms of blood loss, hemodynamic stability, and early postoperative analgesia. Larger randomised controlled trials with standardised anaesthetic protocols and blinded outcome assessment are needed to confirm these observations and to explore longer-term recovery metrics.

Conclusion
When MAP is maintained between 60–80 mmHg, spinal anaesthesia for selected lumbar spine surgeries was associated with lower intraoperative blood loss, smaller heart-rate changes, higher surgeon and patient satisfaction, and reduced need for additional analgesia at 24 hours compared with general anaesthesia. These results support consideration of spinal anaesthesia as an alternative to general anaesthesia in appropriately selected patients

List of Abbreviations
ASA: American Society of Anaesthesiologists
GA: General Anaesthesia
SA: Spinal Anaesthesia
MAP: Mean Arterial Pressure
PACU: Post-Anaesthesia Care Unit
PONV: Postoperative Nausea and Vomiting
Hb: Haemoglobin
SD: Standard Deviation
IQR: Interquartile Range
SPSS: Statistical Package for the Social Sciences

Declarations
Ethics approval and consent to participate
The study obtained ethics approval from the ethical committee of the Faculty of Medicine, Jabir Ibn Hayyan Medical and Pharmaceutical University (No.488 JMU-6th. Jan 2022). All procedures were performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

Consent for Publication
All the authors gave consent for the publication of the work under the Creative Commons Attribution Non-Commercial 4.0 license.

Availability of Data and Materials
De-identified study data are available from the corresponding author on reasonable request.

Competing interests
The authors declare no competing interests.

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Author contributions
ANA: Conceptualisation; Methodology; Investigation; Data curation; Formal analysis; Writing – original draft; Writing – review & editing; Project administration.
KHK: Methodology; Supervision; Validation; Interpretation of data; Writing – review & editing; Critical revision of the manuscript for important intellectual content.
MAJ: Data curation; Resources; Visualisation; Writing – review & editing; Assistance with interpretation of clinical and intraoperative findings.

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