E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.48047/ijprt/15.02.121

Comparison of Hemodynamic Stability in Spinal versus General Anesthesia During Lower Abdominal Surgeries

Marriam Bilal[1], Muhammad Kashan Siddiqui[2], Ghazia Raza[3], Arslan Saleem[4], Mahmood Ahmad Zahid[5], Maria Aslam[6]

Affiliations:
[1] MBBS, Central Park Medical College.
[2] Senior registrar, Shalamar Institute of Health Sciences.
[3] Medical officer, Fauji Foundation Hospital, Sargodha.
[4] Medical officer, Social Security Hospital, KLP, Lahore.
[5] Senior registrar, Poonch Medical College, SKBZ/CMH Rawalakot, Azad Kashmir.
[6] Medical officer, Hameed Latif Hospital, Lahore.

Corresponding author: marriambilal1997@gmail.com

Abstract

Lower abdominal surgeries are commonly performed under either spinal anesthesia (SA) or general anesthesia (GA), yet comparative data regarding intraoperative hemodynamic stability remain limited. In this randomized controlled study, 160 patients undergoing elective lower abdominal procedures were allocated to receive SA with 12.5 mg hyperbaric bupivacaine or GA with propofol-remifentanil maintenance. Primary endpoints included intraoperative mean arterial pressure (MAP) and heart rate (HR) variability; secondary outcomes consisted of vasopressor requirement and incidence of hypotensive episodes. The SA group experienced a significantly lower average ΔMAP from baseline (-12.4 ± 6.5 mmHg vs -18.7 ± 8.2 mmHg; $p < 0.001$) and fewer vasopressor interventions (15% vs 35%; $p = 0.003$). Heart rate remained more stable in the SA cohort (ΔHR: $+1.2 \pm 4.3$ bpm vs -3.8 ± 5.1 bpm in GA; $p < 0.001$). Episodes of clinically significant hypotension (MAP <65 mmHg) occurred less frequently under SA (8% vs 22%; $p = 0.005$). No serious adverse events were observed. These findings demonstrate that spinal anesthesia offers superior intraoperative hemodynamic stability compared with general anesthesia, with reduced vasopressor need and hypotension risk. This study supports spinal anesthesia as a preferred option for maintaining cardiovascular homeostasis during lower abdominal surgery.

Keywords: spinal anesthesia; general anesthesia; hemodynamic stability.

Introduction

Ensuring hemodynamic stability remains a critical anesthetic goal during lower abdominal procedures, as intraoperative variations in blood pressure and heart rate can increase the risk of myocardial injury, acute kidney injury, and delayed recovery (2024). Anesthetic technique significantly influences these parameters: spinal anesthesia (SA), by providing sympathetic blockade, may reduce nociceptive stress but predisposes to hypotension, whereas general anesthesia (GA) often maintains stable hemodynamics but can suppress cardiovascular reflexes (2025).1-3

Recent evidence highlights the clinical significance of minimizing MAP declines; brief episodes below 65 mmHg correlate with adverse outcomes, even during short procedures (2025) . Additionally, autonomic modulation by anesthetic modality may affect heart rate variability, which influences intraoperative tolerance and postoperative recovery .4-5

Earlier studies in hernia repair and laparoscopic cholecystectomy have suggested better MAP and HR stability with SA . However, these trials frequently lacked adequate power or broad applicability, and randomized comparison in elective lower abdominal surgeries remains limited. Moreover, vasopressor requirement—a surrogate for hemodynamic perturbation—has received inconsistent attention .6-7

To address these gaps, the present randomized trial was designed to compare intraoperative MAP and HR changes, vasopressor use, and incidence of significant hypotension between SA and GA in elective lower abdominal surgeries performed by experienced anesthesia teams. By quantifying hemodynamic dynamics in a controlled setting, this study aims to guide technique selection for enhanced perioperative safety and efficient resource utilization.8-10

Methodology

A prospective randomized controlled trial was conducted in adult patients aged 18–65 years at Central Park Medical College (ASA I–II) scheduled for elective lower abdominal surgeries of expected duration under 120 minutes. Exclusion criteria included cardiovascular comorbidities (e.g., uncontrolled hypertension, arrhythmia), BMI ≥35 kg/m², contraindication to regional

anesthesia, known difficult airway, or significant renal/hepatic dysfunction. After written informed consent, 160 patients were randomly allocated (computer-generated blocks) to SA or GA groups.

SA was performed at L3–L4 with 12.5 mg hyperbaric bupivacaine. GA induction involved propofol (2 mg/kg) and remifentanil infusion, with maintenance using target-controlled infusion maintaining BIS within 40–60. Baseline MAP and HR recorded after 5 minutes of rest; further measurements taken every 5 minutes intraoperatively. Vasopressor use (ephedrine 5 mg bolus for MAP < 65 mmHg), total administered doses, and hypotensive episodes were documented.

Sample size was calculated using Epi Info v7.2 to detect a 20% difference in ΔMAP between groups, with α=0.05 and power of 80%, resulting in a requirement of 72 subjects per arm; to allow for attrition, 80 per arm were enrolled. Anesthesiologists and data collectors were blinded to group assignments.

Statistical analysis was performed using SPSS v28. Continuous variables were tested for normality (Shapiro–Wilk) and expressed as mean ± SD. Group comparisons were made using independent t-tests and chi-square tests. Incidence of hypotension and vasopressor use between groups compared by Fisher's exact test. Significance was established at $p < 0.05$.

Results

Table 1. Baseline characteristics

Variable	SA (n=80)	GA (n=80)	p-value
Age (years)	47.2 ± 11.5	48.6 ± 10.9	0.45
Male, n (%)	38 (48%)	42 (53%)	0.52
BMI (kg/m²)	27.1 ± 3.4	27.5 ± 3.6	0.40
Baseline MAP (mmHg)	95.3 ± 9.1	96.8 ± 8.7	0.30
Baseline HR (bpm)	78.4 ± 10.2	76.9 ± 9.8	0.38

Table 2. Intraoperative hemodynamic changes and vasopressor use

Parameter	**SA**	**GA**	**p-value**
ΔMAP (mmHg from baseline)	–12.4 ± 6.5	–18.7 ± 8.2	<0.001
ΔHR (bpm from baseline)	+1.2 ± 4.3	–3.8 ± 5.1	<0.001
Vasopressor use, n (%)	12 (15%)	28 (35%)	0.003
Hypotension episodes (<65 mmHg), n (%)	6 (8%)	18 (22%)	0.005

Table 3. Extent and duration of hypotension

Measure	**SA**	**GA**	**p-value**
Total vasopressor dose (mg ephedrine)	8.3 ± 2.1	12.6 ± 3.5	<0.001
Duration of MAP <65 mmHg (minutes)	2.8 ± 1.5	5.4 ± 2.2	<0.001

Baseline characteristics were comparable. SA group exhibited significantly less MAP and HR deviation, lower rates and doses of vasopressors, and shorter duration of hypotension compared with GA (all $p < 0.005$).

Discussion

Spinal anesthesia demonstrated superior hemodynamic control during elective lower abdominal surgery, as evidenced by reduced MAP and HR variability, fewer vasopressor interventions, and lower incidence and duration of intraoperative hypotension. These findings corroborate prior non-randomized and observational studies indicating better cardiovascular homeostasis under SA (Science Publishing Group). In hernia repair, SA maintained MAP stability in 56% of patients versus 40% with GA (ClinSurge Group); the present randomized data validate those observations.11-13

The physiologic basis for hemodynamic advantages with SA lies in sympathetic blockade that blunts nociceptive-driven catecholamine surges while preserving baroreflex-mediated heart rate adjustments. In contrast, GA-mediated myocardial suppression and vasodilation contribute to greater cardiovascular perturbation.14-16

Vasopressor requirement also highlights technique impact. SA group needed 15% interventions compared to 35% under GA, with lower total ephedrine consumption, underscoring the lower risk of total hemodynamic disruption. This aligns with maternal studies using prophylactic SA methods showing reduced vasopressor need.17-20

Hypotension severity and duration were significantly mitigated under SA—a finding clinically relevant because even short hypotensive episodes (<5 min) are associated with postoperative organ dysfunction . The SA group's mean duration of hypotension was ~3 minutes versus ~5.4 for GA ($p < 0.001$), indicating a meaningful safety advantage.

Potential limitations include inability to blind anesthesiologists to technique, single-center design, and focus on short elective procedures; results may not extrapolate to emergency or complex cases. Additionally, BIS monitoring was not performed under SA, though depth of anesthesia is less relevant in regional blocks.

Nonetheless, the methodology—randomization, standardized dosing, objective hemodynamic monitoring—strengthens internal validity. The findings support SA as a technique of choice when cardiovascular stability is a priority, and raise consideration for preferential use in resource-limited settings where vasopressor availability is limited.

Future research should explore combining SA with light GA ("combined technique") to maintain hemodynamic stability while providing sedation and patient comfort, and extending follow-up to include recovery and morbidity endpoints.

Conclusion

Spinal anesthesia provides superior intraoperative hemodynamic stability during lower abdominal surgeries compared to general anesthesia, with reduced vasopressor use and shorter hypotensive episodes. This supports the preferential use of spinal technique to enhance perioperative cardiovascular safety.

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