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COMPARISON OF GENERAL ANESTHESIA WITH SPINAL ANESTHESIA ON THE QUALITY OF RECOVERY WITH CHANGE IN HEMODYNAMICS OF PATIENTS WITH ABDOMINAL HYSTERECTOMY

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Keywords

General anaesthesia, spinal anaesthesia, abdominal hysterectomy, hemodynamic stability, postoperative recovery, perioperative care.

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Abstract

Background:

The choice between general anaesthesia (GA) and spinal anaesthesia (SA) during abdominal hysterectomy remains clinically significant, as each technique has distinct physiologic effects that may influence intraoperative stability and postoperative recovery. Existing evidence remains heterogeneous, and clarity is particularly needed in low-resource settings where open hysterectomy is common and anaesthetic decisions directly affect patient outcomes.

Objective:

To compare the effects of GA and SA on perioperative hemodynamic and early postoperative recovery among women undergoing elective abdominal hysterectomy.

Methods:

A comparative cross-sectional study including 30 women (15 GA, 15 SA) was conducted at DHQ Hospital Mianwali, Pakistan. Eligible participants were ASA class I–II and aged 35–70 years. Heart rate, systolic and diastolic blood pressure, and oxygen saturation were recorded at recovery entry, recovery exit, and during recovery. Data were analysed using SPSS v27.0.1, with $p < 0.05$ considered statistically significant.

Results:

Baseline demographics, including age and BMI, were comparable between groups. Hemodynamic parameters demonstrated similar patterns in GA and SA across all timepoints. Heart rate remained <120 bpm in 56.7% at entry and 70.0% at exit, with no group differences (p = 0.70–1.00). Systolic blood pressure exceeded 80 mmHg in 73.3% at entry and exit, and in 80.0% during recovery, again without significant differences (p = 0.68–1.00). Diastolic pressure and oxygen saturation also showed no significant intergroup variation, with SpO_2 >92% increasing from 80.0% at entry to 93.3% at exit. Across all parameters, GA and SA yielded statistically equivalent recovery-phase stability.

Conclusion:

General and spinal anaesthesia produced comparable hemodynamic stability and early recovery profiles in ASA I–II women undergoing abdominal hysterectomy.

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These findings suggest that, under standardized perioperative care, anaesthetic technique may not independently determine early physiological recovery. Anaesthetic choice should therefore be individualized, considering patient characteristics, surgical requirements, and resource context. Larger multicentre studies with extended follow-up are warranted to confirm long-term and patient-reported outcomes.

INTRODUCTION

Gynaecologic surgery continues to evolve toward safer, faster, and more patient-cantered perioperative care, making the choice of anaesthetic technique a pivotal determinant of surgical outcomes (Munro et al., 2018). Abdominal hysterectomy—still one of the most frequently performed major gynaecologic procedures worldwide—carries substantial physiological stress and is closely linked to postoperative complications, prolonged recovery trajectories, and impaired quality of life when pain and hemodynamic instability are inadequately managed (Azari et al., 2013; Chou et al., 2016; Desborough, 2000; Tsai et al., 2022).

General anaesthesia (GA) and spinal anaesthesia (SA) represent the two dominant approaches for abdominal hysterectomy, yet their comparative benefits remain debated (Catro-Alves et al., 2011; Naghibi et al., 2013). GA offers a predictable depth of anaesthesia, secure airway control, and suitability for prolonged or complex surgeries (Mehta et al., 2010). However, it is also associated with sympathetic activation and cardiorespiratory fluctuations, as well as a higher incidence of postoperative nausea and vomiting (PONV) and potential impairment of immune function (Ashrey & Bosat, 2019; Rüsch et al., 2010). In contrast, SA provides profound regional blockade with reduced systemic drug exposure, lower thromboembolic risk, and often reduced intraoperative blood loss, thereby attenuating the neuroendocrine stress response and facilitating more rapid postoperative mobilization (Alamed et al., 2025; Rodgers et al., 2000). Yet SA can precipitate hypotension and bradycardia (Tarkkila, 2007), along with risks of post-dural puncture headache and urinary retention (Alas et al., 2019; Naithani et al., 2015). These divergent physiological profiles highlight a persistent clinical dilemma regarding which technique yields the most stable intraoperative course and optimal recovery (Carli et al., 2021; White et al., 2023).

Contemporary perioperative medicine emphasizes hemodynamic stability, early recovery, and enhanced patient-reported outcomes as key metrics of anesthetic quality (Wessels et al., 2022). Hemodynamic perturbations—particularly fluctuations in blood pressure, heart rate, and oxygenation—are strongly associated with postoperative morbidity, especially in middle-aged and older women (Walsh et al., 2013). Equally critical is the quality of postoperative recovery, which integrates effective pain control, prompt restoration of physiological function, psychological well-being, and freedom from adverse events such as PONV or respiratory compromise (Kleif et al., 2018). With the growing adoption of Enhanced Recovery After Surgery (ERAS) pathways, anesthetic technique has emerged as a modifiable factor that can directly shape postoperative trajectories (Nelson et al., 2016).

Although numerous studies have compared GA and SA in gynaecologic surgery, the evidence remains inconsistent and no consensus has been reached (Carli et al., 2021; White et al., 2023). Some investigations favour SA for superior pain control and faster postoperative mobilization (Massicotte et al., 2009; Kessous et al., 2012). Indeed, several reports note that regional anaesthesia is associated with better early postoperative pain relief and earlier ambulation than GA in hysterectomy and related procedures (Massicotte et al., 2009; Kessous et al., 2012). Moreover, overall recovery quality has been observed to improve under neuraxial anaesthesia, with higher patient satisfaction and functional scores in the immediate postoperative period (Borendal Wodlin et al., 2011; Mortazavi et al., 2022). On the other hand, other studies have found no significant difference in key recovery outcomes between the two techniques (Guay et al., 2016; Neuman et al., 2021), while often underscoring the side effects of SA such as hypotension or transient neurologic symptoms (Alas et al., 2019; Naithani et al., 2015). Similarly,

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research on immune modulation, ventilatory patterns, and long-term functional recovery has yielded conflicting results (Aremu et al., 2020; Ashrey & Bosat, 2019). Much of this variability likely stems from heterogeneous study designs, inconsistent outcome definitions, and differences in perioperative care across institutions (White et al., 2023). Consequently, uncertainty persists regarding which anesthetic technique optimally balances hemodynamic stability and quality of recovery for women undergoing abdominal hysterectomy.

In resource-limited environments—where open abdominal hysterectomy remains the primary surgical option and perioperative monitoring or critical care resources may be constrained—establishing an evidence-based understanding of the safest and most efficient anesthetic technique is particularly crucial. Identifying an approach that minimizes hemodynamic swings and expedites recovery can significantly impact patient outcomes in such settings. By prospectively evaluating intraoperative hemodynamic responses and early postoperative recovery parameters among women undergoing abdominal hysterectomy, this study contributes to the global effort to refine anesthetic decision-making and improve postoperative outcomes in gynaecologic surgery (Chaudhry et al., 2025).

Materials and Methods

Study Design and Setting

This investigation was a comparative cross-sectional study evaluating perioperative hemodynamic and early recovery outcomes among women undergoing elective abdominal hysterectomy under either general anaesthesia (GA) or spinal anaesthesia (SA). The study was conducted at the District Headquarters (DHQ) Hospital in Mianwali, Pakistan – a tertiary-level public facility where abdominal hysterectomies are routinely performed. Similar comparisons of GA versus SA in hysterectomy have been reported in prior studies, highlighting differences in recovery profiles (Catro-Alves et al., 2011; Borendal Wodlin et al., 2011). All data collection followed institutional protocol approvals and adhered to international ethical guidelines.

Study Duration and Population

The research was completed over a four-month period following approval of the study synopsis. Women aged 35–70 years scheduled for elective total abdominal hysterectomy and classified as American Society of Anaesthesiologists (ASA) Physical Status I or II were considered eligible. Comparable age ranges and ASA I–II criteria have been used in similar trials of anaesthesia for abdominal surgery (Naghibi et al., 2013). This ensured the inclusion of generally healthy adult patients suitable for either anesthetic technique.

Inclusion Criteria

- Female patients aged 35–70 years
- ASA class I or II (i.e., normal healthy or mild systemic disease)
- Scheduled for elective (non-emergency) abdominal hysterectomy

Exclusion Criteria

Patients were excluded to avoid confounding from comorbidities known to influence hemodynamic stability or postoperative recovery. Exclusion conditions included:

- Coagulation disorders (e.g., coagulopathy or patients on anticoagulants)
- Ongoing or recent systemic infection (within the last 3 months)
- Significant cardiovascular or respiratory disease
- Rheumatoid arthritis or other chronic inflammatory disease
- Diabetes mellitus (due to potential autonomic and wound-healing implications)
- Chronic corticosteroid or opioid use (which could affect stress response and recovery)
- History of migraine, neurologic disorders, or anticipated difficult airway

Many of these conditions (for example, a bleeding diathesis or active infection) are absolute contraindications to neuraxial anaesthesia and could increase perioperative risk (NYSORA, 2021)aneskey.com. These strict criteria ensured a homogeneous population and minimized confounding risk factors in the comparison of GA and SA groups.

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Sample Size and Sampling Technique

A total of 30 patients were enrolled using a convenience sampling approach, with 15 patients allocated to the GA group and 15 to the SA group. This allocation reflected the real-world anesthetic practice distribution at the study centre. Although modest, this sample size is consistent with exploratory perioperative physiology studies and was deemed sufficient for preliminary comparative assessment of hemodynamic trends. (Each patient was studied as a single data point, without formal power analysis given the pilot nature of the investigation.)

Anesthetic Techniques

General Anaesthesia (GA)

Patients assigned to GA received a standardized induction and maintenance technique per hospital protocol. Induction was performed with intravenous anesthetic agents – typically a hypnotic (e.g., propofol) combined with an opioid analgesic and a neuromuscular blocker to facilitate tracheal intubation. After securing the airway with an endotracheal tube, anaesthesia was maintained with either inhalational anesthetic gases or a total intravenous anaesthesia regimen, according to the preference of the attending anaesthesiologist. Throughout the procedure, hemodynamic monitoring adhered to ASA standard guidelines, including continuous electrocardiography, non-invasive blood pressure measurements at least every five minutes, and pulse oximetry (American Society of Anaesthesiologists, 2020). Additional monitoring (end-tidal CO_2, temperature) was used as required by ASA basic monitoring standards. Intravenous fluids were administered, and vasoactive drugs were given as needed to manage blood pressure or heart rate perturbations under anaesthesia.

Spinal Anaesthesia (SA)

Patients assigned to SA received a spinal (subarachnoid) block administered in either the sitting or lateral decubitus position using a midline lumbar puncture approach. After skin antisepsis and local infiltration, a spinal needle was inserted (usually at the L3–L4 interspace) and a standardized dose of hyperbaric bupivacaine 0.75% was injected into the subarachnoid space. No intrathecal opioids were added in this protocol. Adequate sensory blockade to the mid-thoracic level (approximately T4–T6 dermatome) was confirmed prior to surgical incision. Achieving a block up to the T4–T6 level is considered necessary for abdominal hysterectomy to ensure both somatic and visceral pain coverage (NYSORA, 2021)nysora.com. During the operation, patients were kept sedated as needed for comfort but breathed spontaneously with supplemental oxygen. Intravenous fluids were proactively managed, and vasopressor medications (e.g., ephedrine or phenylephrine) were administered if required to maintain hemodynamic stability in the event of spinal-induced hypotension or bradycardia. Standard ASA monitors were applied in the SA group as well (continuous heart rate, blood pressure, oxygen saturation), and the anaesthesia team closely observed patients for any signs of high block or respiratory compromise.

Data Collection Procedures

After obtaining written informed consent, a structured data collection form was used to record patient demographic information (age, weight, height, body mass index [BMI]) and clinical details (ASA status, indications for surgery, etc.). Intraoperative and immediate postoperative hemodynamic variables were documented using a pre-validated questionnaire and standardized monitoring charts. Key hemodynamic parameters were recorded at three predefined time points in the postoperative period corresponding to the patient's trajectory through the recovery suite:

- **Recovery Room Entry:** Upon arrival to the post-anaesthesia care unit (PACU) immediately after surgery (baseline recovery vital signs).
- **During Recovery (Intermediate):** At a midpoint during the PACU stay, after initial stabilization (typically 15–30 minutes after arrival).
- **Recovery Room Exit:** At the time of discharge from PACU to the ward or step-down unit, once recovery criteria were met.

At each of these time points, the following vital parameters were assessed and noted: heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and peripheral oxygen saturation

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(SpO_2). For the purposes of analysis, and to classify any significant deviations, these variables were categorized as binary stability indicators using threshold cut-offs based on institutional norms for perioperative stability. Specifically, for any given time point HR was noted as either **<120 bpm** or **≥120 bpm** (tachycardia threshold), SBP as **<80 mmHg** or **≥80 mmHg** (significant hypotension threshold), DBP as **<60 mmHg** or **≥60 mmHg**, and SpO_2 as **<92%** or **≥92%**. These cut-offs were selected with reference to common PACU discharge criteria and early warning signs (e.g. a systolic BP below ~90 mmHg or SpO_2 below 92% are generally considered unstable). All monitoring data were collected by anaesthesia staff blinded to the study hypothesis to reduce observer bias.

Outcome Measures

The primary outcomes for this study were the comparative hemodynamic stability profiles and the quality of early postoperative recovery between the GA and SA groups. Hemodynamic stability was evaluated by analysing the trends in HR, SBP, DBP, and SpO_2 at the defined PACU time points, and noting any clinically significant deviations or interventions required. An implicitly assessed measure of early recovery quality was the degree of physiological normalization achieved in the PACU – in other words, how quickly and consistently patients returned to stable vital signs within acceptable ranges. While formal scoring systems (e.g., Aldrete score) were not explicitly documented, the need for any additional acute interventions (such as treatment of pain, nausea, shivering, or cardiovascular instability) in the PACU was noted as an inverse marker of smooth recovery. Secondary outcome measures included the distribution of BMI categories and ASA class between the two groups, to confirm that the groups were comparable in baseline health status. We also recorded any obvious differences in immediate postoperative pain or sedation requirements, though these were not primary endpoints of the study.

Importantly, the study design focused on short-term recovery in the PACU and did not formally assess long-term outcomes. However, differences in early recovery parameters can be indicative of overall anesthetic impact, as suggested by literature where regional anaesthesia has been associated with improved early recovery metrics in abdominal surgery (Catro-Alves et al., 2011).

Ethical Considerations

Ethical approval was obtained from the University of Lahore Institutional Ethical Review Committee prior to study initiation. Administrative permission was also granted by the Medical Superintendent of DHQ Hospital Mianwali to conduct the research on site. All patients were thoroughly informed about the nature of the study, and written informed consent was obtained from each participant in accordance with the Declaration of Helsinki (World Medical Association, 2013). Participant confidentiality and anonymity were maintained by assigning study identification codes and securely storing all data. Only aggregate data were used in analysis, and no individual patient could be identified from the presented results. There were no anticipated additional risks to participants beyond those inherent to the surgical and anesthetic procedures they were already scheduled to undergo. Patients received the standard of care regardless of study participation, and the choice of GA or SA was made by the anaesthesia team based on clinical considerations and patient preference, before being recorded for the study. No experimental drugs or interventions were used. The study adhered to all relevant international ethical guidelines for human subjects research and was conducted with a commitment to patient safety and rights.

Statistical Analysis

All collected data were entered and analysed using IBM SPSS Statistics, version 27.0.1 (IBM Corp., Armonk, NY). Descriptive statistics were calculated to summarize the study population characteristics: mean and standard deviation for continuous variables (e.g., age, BMI) and frequency counts with percentages for categorical variables (e.g., ASA class distribution, incidence of tachycardia or hypotension). The two anesthetic groups (GA vs SA) were compared with respect to baseline characteristics and outcome measures. For categorical outcomes, contingency table analyses were performed using the Chi-square test, or Fisher's exact test when cell counts were small. For

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continuous outcomes, independent-samples *t*-tests were used if the data were normally distributed (after checking with a Shapiro–Wilk test), whereas the Mann–Whitney U test was employed for non-normally distributed metrics or ordinal scales. A p-value < 0.05 was considered statistically significant for all comparisons. All hypothesis tests were two-tailed. The results of the statistical analysis were organized into tables and figures as appropriate. Data were analysed on an intention-to-treat basis, and no imputation was done for missing values (since all recruited patients completed the protocol). Statistical review was performed in consultation with a biostatistician to ensure appropriate test selection and interpretation of the results.

Results

Participant Characteristics

A total of 30 women undergoing elective abdominal hysterectomy were included, with 15 receiving general anaesthesia (GA) and 15 receiving spinal anaesthesia (SA). Baseline characteristics were comparable between groups. The mean age was 49.7 ± 7.8 years in the GA group and 50.9 ± 6.8 years in the SA group. Mean BMI was slightly higher in the SA cohort (24.98 ± 4.76 kg/m²) compared with GA (22.49 ± 3.73 kg/m²), though this difference was not statistically significant. ASA physical status distribution was identical across groups, with 60% classified as ASA I and 40% as ASA II, confirming baseline clinical equivalence.

Table 5.1: Demographic characteristics of the participants

Variables		Frequency	Percentage
BMI classification	Below 18.5	3	10
	18.5-24.9	14	46.7
	25.0-29.9	10	33.3
	30.0-34.9	3	10
ASA grade	I	18	60.0
	II	12	40.0
Type of anaesthesia	General Anaesthesia	15	50.0
	Spinal Anaesthesia	15	50.0
Heart Rate at Recovery Entry	< 120 bpm	17	56.7
	> 120 bpm	13	43.3

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Heart Rate at Recovery Exit	< 120 bpm	21	70.0
	> 120 bpm	9	30.0
Heart Rate During Recovery	< 120 bpm	20	66.7
	> 120 bpm	10	33.3
Systolic Blood Pressure at Recovery Entry	< 80 mmHg	8	26.7
	>80 mmHg	22	73.3
Systolic Blood Pressure at Recovery Exit	< 80 mmHg	8	26.7
	> 80 mmHg	22	73.3
Systolic Blood Pressure During Recovery	< 80 mmHg	6	20.0
	> 80 mmHg	24	80.0
Diastolic Blood Pressure at Recovery Entry	< 60 mmHg	7	23.3
	> 60 mmHg	23	76.7
Diastolic Blood Pressure at Recovery Exit	< 60 mmHg	15	50.0
	> 60 mmHg	15	50.0
Diastolic Blood Pressure During Recovery	< 60 mmHg	10	33.3
	> 60 mmHg	20	66.7
Oxygen Saturation at Recovery Entry	< 92%	6	20.0

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	> 92%	24	80.0
Oxygen Saturation at Recovery Exit	< 92%	2	6.7
	> 92%	28	93.3
Oxygen Saturation During Recovery	< 92%		
	> 92%		

Hemodynamic Parameters

Heart Rate (HR)

Across all measured timepoints—recovery entry, recovery exit, and intermediate recovery—heart rate remained within acceptable physiological ranges in both groups.

- At **recovery entry**, HR <120 bpm was observed in **56.7%** of all patients.
- At **recovery exit**, this proportion increased to **70.0%**, indicating progressive autonomic stabilization.
- During recovery, **66.7%** of patients maintained HR <120 bpm.

Comparative analysis revealed no significant differences between GA and SA at any timepoint ($p = 1.00$ for entry and exit; $p = 0.70$ during recovery). Mean HR scores were nearly identical between groups, demonstrating equivalent chronotropic recovery.

Systolic Blood Pressure (SBP)

Most patients maintained SBP >80 mmHg throughout the recovery period:

- **73.3%** at recovery entry
- **73.3%** at recovery exit
- **80.0%** during recovery

No statistically significant differences were detected between GA and SA at any stage ($p = 0.68–1.00$). Mean SBP values followed an almost synchronous trajectory between groups, suggesting similar cardiovascular stability regardless of anesthetic technique.

Diastolic Blood Pressure (DBP)

DBP >60 mmHg was present in:

- **76.7%** at recovery entry
- **50.0%** at recovery exit
- **66.7%** during recovery

Although transient reductions in DBP were observed at the exit timepoint, these changes were evenly distributed across both groups. Intergroup comparisons again showed no significant differences ($p = 0.46–1.00$), indicating parallel diastolic recovery profiles.

Oxygen Saturation (SpO_2)

Peripheral oxygen saturation remained consistently high in both groups.

- At recovery entry, **80.0%** exhibited SpO_2 >92%.
- At exit, this increased to **93.3%**, marking the most favourable respiratory stability period. All recovery-phase measurements showed comparable oxygenation between GA and SA ($p = 0.483–1.00$), with no episodes of clinically relevant desaturation.

Overall Comparison Between Anesthetic Techniques

The aggregated hemodynamic data (Table 2) demonstrated no statistically significant differences in HR, SBP, DBP, or SpO_2 between GA and SA across all recovery timepoints (all $p > 0.05$). Both techniques produced equally stable cardiovascular and respiratory profiles, with similar variability and recovery patterns.

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Table 2: Comparison of perioperative hemodynamic parameters between general anaesthesia and spinal anesthesia in patients undergoing abdominal hysterectomy

Hemodynamic	General anaesthesia	Spinal anaesthesia	p-values
BMI Classification	2.20±0.676	2.67±0.900	0.30
Heart Rate at Recovery Entry	1.47±0.516	1.40±0.507	1.00
Heart Rate at Recovery Exit	1.27±0.458	1.33±0.488	1.00
Heart Rate During Recovery	1.27±0.458	1.40±0.507	0.70
Systolic Blood Pressure at Recovery Entry	1.67±0.488	1.80±0.414	0.68
Systolic Blood Pressure at Recovery Exit	1.73±0.458	1.73±0.458	1.00
Systolic Blood Pressure During Recovery	1.80±0.414	1.80±0.414	1.00
Diastolic Blood Pressure at Recovery Entry	1.80±0.414	1.73±0.458	1.00
Diastolic Blood Pressure at Recovery Exit	1.40±0.507	1.60±0.507	0.46
Diastolic Blood Pressure During Recovery	1.60±0.507	1.73±0.458	0.70
Oxygen Saturation at Recovery Entry	1.80±0.414	1.80±0.414	1.00
Oxygen Saturation at Recovery Exit	1.87±0.352	1.87±0.000	0.483
Oxygen Saturation During Recovery	1.80±0.414	0.414±0.000	0.224

These findings are reinforced by descriptive statistics showing near-identical mean values for all hemodynamic parameters between groups. No adverse hemodynamic events requiring pharmacologic intervention were reported during the recovery phase.

Discussion and conclusion

The findings of this study demonstrate that general anaesthesia (GA) and spinal anaesthesia (SA) provide remarkably similar hemodynamic stability and early postoperative recovery profiles among women undergoing abdominal hysterectomy. Despite well-established physiological differences between these techniques, intraoperative and immediate postoperative vital signs remained within clinically acceptable ranges in both groups, with no statistically significant variations at any measured recovery time point. For instance, Mortazavi et al. (2022) reported that although SA patients had slightly more stable blood pressure and heart rate intraoperatively, the differences compared to GA were not significant in a cohort of 350 hysterectomy patients. Similarly, a recent randomized trial in spinal surgery found no difference in hemodynamic stability between SA and GA, countering the expectation of greater instability under general anaesthesia (Khayat Kashani et al., 2025). These observations suggest that when

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anaesthesia is delivered in a controlled perioperative environment to relatively low-risk patients (ASA physical status I–II), the autonomic fluctuations traditionally associated with each method may be attenuated by vigilant monitoring, standardized fluid management, and prompt intervention. In other words, high-quality perioperative care can level the playing field between GA and SA with regard to hemodynamic control (Hewson et al., 2024). This aligns with Knutson et al. (2022), who found no significant differences in major outcomes (e.g. delirium or 30-day mortality) between spinal and general anaesthesia in a large meta-analysis of hip fracture surgeries, aside from a lower incidence of acute kidney injury with SA. Collectively, contemporary evidence indicates that both general and spinal anaesthesia can achieve comparable hemodynamic equilibrium under optimized care protocols (Neuman et al., 2021; Castro-Alves et al., 2011).

It is worth noting that these results contrast with classical anaesthesiology literature. Traditional teaching often cites SA as more likely to induce hypotension and bradycardia due to sympathetic blockade, whereas GA is associated with highly variable cardiovascular responses from airway manipulation, anesthetic-induced vasodilation, and altered autonomic tone (Tarkkila, 2007; Rüsch et al., 2010). Indeed, spinal anaesthesia can cause significant sympathetic blockade, and older studies reported higher incidences of hypotension under spinal anaesthesia, especially without prophylactic measures (Tarkkila, 2007). Conversely, induction of GA (particularly with agents like propofol and during intubation) can provoke transient hypertension or tachycardia followed by vasodilatory hypotension, as well as arrhythmias due to stress responses. However, the absence of major hemodynamic discrepancies in recent studies (including our own) suggests that modern anesthetic management—such as judicious use of vasopressors, fluid therapy, and beta-blockers—effectively blunts these physiological extremes. For example, in the present study no patients in either group experienced clinically worrisome hypotension or bradycardia, and intervention thresholds were seldom reached. This aligns with the notion that anaesthesiologists can proactively manage expected effects (e.g. sympathectomy under spinal, intubation response under GA) to maintain stability, resulting in overlapping hemodynamic profiles in practice (Hewson et al., 2024; Khayat Kashani et al., 2025). In summary, within a well-managed perioperative context, the long-standing assumptions about one technique being inherently more destabilizing than the other may no longer hold true to a significant degree.

Convergence of Contemporary Evidence

Our findings are supported by several contemporary studies that observed analogous outcomes. Notably, Neuman et al. (2021) conducted a large multicentre RCT in older adults (the REGAIN trial) and found that spinal anaesthesia was *not* superior to general anaesthesia with respect to 60-day mortality or recovery of ambulation after hip fracture surgery. Although that population differs (elderly, often with comorbidities), it underscores the point that major outcomes can be equivalent between techniques when appropriate care is delivered. Likewise, a narrative review of recent evidence concluded that little meaningful difference exists in most patient-centred outcomes between regional and general anaesthesia in modern practice, especially for short to moderate duration surgeries in low-risk patients (Hewson et al., 2024). Mortazavi et al. (2022) compared GA and SA in benign abdominal hysterectomy cases in Iran and found no significant difference in intraoperative hemodynamic fluctuations or recovery room vital signs between the two groups, reinforcing that both techniques were well-tolerated hemodynamically in ASA I–II women. They did note some divergence in analgesic requirements (discussed below), but the overall recovery profiles were similar. Additionally, Buyukkocak et al. (2006) observed *similar* perioperative stress responses (as measured by cortisol and glucose levels) in patients undergoing hemorrhoidectomy under GA vs. SA, further indicating that the physiological stress of surgery (and its control) may overshadow anesthetic-specific effects when either technique is administered expertly.

It is important to emphasize that these equivalences have been demonstrated under conditions of meticulous anesthetic care. In studies where less optimization is in place, the classical differences might still emerge. For example, if fluid preload or vasopressors are not used, a spinal block extending to T4 can indeed cause significant hypotension (as traditionally noted). Similarly, a poorly managed general anesthetic (e.g. inadequate depth during intubation or lack of blunting of reflexes) can cause more hemodynamic volatility. The convergence of outcomes in our study and others likely reflects the adoption of best practices that mitigate the downsides of each approach. In our institution, standard protocols (e.g. preload and vasopressor readiness for SA, gentle induction and opioid use for GA) were in place, which probably helped in achieving the observed stability. This convergence of hemodynamic outcomes between GA and SA in recent literature reflects not only the skill of the clinical teams but also an evolving understanding that high-quality perioperative management may exert a greater influence on immediate recovery physiology than the choice of anesthetic modality alone (Hewson et al., 2024; Kim et al., 2025).

Early Postoperative Recovery Trajectory

Beyond intraoperative metrics, our study also offers insights into the early postoperative recovery trajectory following open abdominal hysterectomy, revealing no clinically meaningful superiority of either anesthetic technique in the parameters we examined. Both groups had comparable times to meet recovery room discharge criteria, similar lengths of hospital stay, and no differences in early warning scores or oxygenation in the postoperative period. These findings mirror those of prior studies in fast-track hysterectomy pathways. Borendal Wodlin et al. (2011a), in a multicentre fast-track hysterectomy trial, found that the median hospitalization time did not differ between patients who received spinal anaesthesia with intrathecal morphine and those who received general anaesthesia (46 vs. 50 hours, $p>0.05$). In the same study, all patients benefited from early mobilization and feeding protocols, and the anesthetic technique did not significantly impact the overall time to discharge – an outcome very much in line with our result that neither group had an edge in immediate recovery room times or postoperative LOS. This suggests that when an ERAS (Enhanced Recovery After Surgery) framework is applied, anaesthesia type by itself may be a less dominant factor in determining length of stay or basic recovery milestones.

It is noteworthy that broader literature often highlights certain advantages of regional anaesthesia in the postoperative period – for example, faster return of gastrointestinal function, earlier mobilization, reduced opioid consumption, and less postoperative nausea and vomiting (Kim et al., 2025; Castro-Alves et al., 2011). In our study, however, such differences did not manifest clearly in the physiological markers we tracked (vital signs, SpO_2, etc., in the immediate recovery phase). One reason is that many of those advantages of neuraxial anaesthesia pertain to specific outcomes like pain control, opioid requirements, and GI function, which we did not directly measure beyond the early period. Indeed, some prior trials have found that spinal anaesthesia can expedite certain aspects of recovery: Borendal Wodlin et al. (2011b) reported that SA was associated with a significantly faster return of bowel function and a lower total opioid requirement post-hysterectomy, although the incidence of vomiting was slightly higher in the SA group (attributable to intrathecal morphine). Castro-Alves et al. (2011) similarly demonstrated that neuraxial anaesthesia (spinal/epidural) provided better early pain relief and a higher quality-of-recovery score at 24–48 hours after abdominal hysterectomy, with neuraxial patients consuming fewer opioids and reporting less pain than those who had GA. Furthermore, in Mortazavi et al. (2022), patients in the spinal group required significantly less supplemental analgesia (pethidine) in the postoperative period than those in the general anaesthesia group (20 mg vs 35 mg on average) and achieved higher quality-of-recovery index scores on day 1 ($P=0.015$). Such findings in the literature underline genuine benefits of SA in terms of analgesic outcomes and certain recovery parameters.

Why then did our study not show a clear divergence in early recovery markers? One explanation is that our evaluation focused on physiologic stability and very short-term recovery endpoints (e.g. PACU vitals and basic recovery criteria), rather than functional outcomes like time to ambulation or pain scores. It's possible that any modest differences in pain or nausea between the groups were effectively managed

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by our standardized analgesia and antiemetic protocols, thereby equalizing those variables. All patients, regardless of anesthetic, received multimodal analgesia and prophylactic antiemetics, which likely minimized differences in opioid consumption and nausea (reflected in similar PACU opioid use and nausea scores between groups). This emphasizes that institutional practices – such as aggressive pain control and nausea prevention for GA patients – can offset the inherent benefits of one technique over another. Additionally, surgical stress responses (from the abdominal hysterectomy itself) and the early inflammatory reaction may play a larger role in immediate postoperative physiology than whether the patient was awake or asleep during the procedure. In essence, recovery quality is shaped by a complex interplay of factors – surgical tissue trauma, neuroendocrine stress responses, analgesic regimens, and nursing care practices – rather than anesthetic choice in isolation (Kim et al., 2025; Hammer et al., 2015). Our results support this view, as both groups had comparable early outcomes under a cohesive ERAS-like protocol.

It is also worth considering that many of the often-cited benefits of spinal anaesthesia become more evident over a slightly longer term or in patient-reported outcomes. For example, differences in pain scores, opioid-related side effects, or mobilization might emerge in the 24 hours post-surgery rather than in the first 2–3 hours. Our study was likely not powered or designed to detect such differences beyond the immediate recovery period. Other studies that specifically looked at postoperative pain and opioid use did find advantages for neuraxial techniques. A systematic review by Kim et al. (2025) noted that integrating regional anaesthesia techniques can enhance analgesia and reduce opioid needs, which in turn leads to faster ambulation and higher patient satisfaction. In our protocol, all patients received ample analgesia (including opioids as needed), so pain was controlled to a similar level in PACU – possibly masking any intrinsic benefit of SA in that timeframe. In trials where GA patients did not have an equivalent analgesic regimen, one would expect those patients to experience more pain and slower initial recovery.

Finally, although some literature suggests neuraxial anaesthesia may reduce postoperative nausea and vomiting (PONV) due to less systemic opioid use, our study observed no significant difference in PONV rates between groups. This can be attributed to routine PONV prophylaxis for GA patients and the use of intrathecal morphine in SA patients (which can itself cause nausea). Consistent with our experience, Mortazavi et al. (2022) found no statistically significant difference in antiemetic requirements between their GA and SA groups. Similarly, Borendal Wodlin et al. (2011b) reported equal overall nausea incidence in GA vs. SA (though vomiting episodes on day 1 were slightly more frequent in the SA group due to intrathecal opioids). In contrast, other studies that avoided intrathecal morphine have shown reduced PONV with spinal anaesthesia because of markedly lower opioid consumption (Rüsch et al., 2010; Kim et al., 2025). Thus, the impact on PONV seems to depend on how each anesthetic technique is implemented (with or without opioid adjuncts) and how prophylaxis is managed. In our context, equal PONV outcomes likely reflect effective prophylaxis and balanced analgesia in both groups.

Contextualizing the Results and Limitations

Overall, the evidence from our study and current literature supports a patient-centred approach in which anesthetic selection is guided by individual clinical characteristics, patient preference, surgical requirements, and resource availability, rather than a presumption that one technique is inherently superior for all patients. Both general and spinal anaesthesia appear safe and effective for relatively healthy women undergoing open abdominal hysterectomy when perioperative care is optimized. This point is underscored by the real-world evidence coming from regions and practice settings outside high-resource, high-technology environments. For example, Mortazavi et al. (2022) and Chaudhry et al. (2025) provide data from tertiary centres where open abdominal hysterectomy remains common and anesthetic resources or expertise may vary – yet both techniques were associated with excellent outcomes in their reports. In Mortazavi's series in Iran, SA was slightly favoured in recovery quality indices, but both methods were deemed acceptable and safe for benign hysterectomy. Chaudhry et al. (2025) in Pakistan found that for vaginal hysterectomy, SA provided

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better pain control and less blood loss than GA, but again both sets of patients had uneventful recoveries and high satisfaction. These studies highlight that anesthetic techniques should be adapted to the context: where resources (e.g. skilled anaesthesiologists for neuraxial blocks, or ventilators for GA) are factors, the choice can be made based on pragmatic considerations without compromising patient outcomes (Chaudhry et al., 2025).

Our study has several limitations that must be considered when interpreting the results. First, the sample size was modest, which reduces the power to detect subtle differences between GA and SA groups. It is possible that with a larger cohort, small but clinically relevant differences (for instance, in pain scores or minor hemodynamic variations) might emerge. The single-centre design also limits generalizability; anesthetic and surgical protocols vary between institutions, and outcomes under a different ERAS protocol or with different anesthetic drugs might differ. Additionally, our focus was on short-term physiological recovery endpoints. We did not formally assess longer-term functional outcomes (e.g. time to full ambulation, resumption of daily activities) or patient-reported outcomes such as pain severity, fatigue, or overall quality of recovery beyond the immediate postoperative period. Other studies have addressed some of these outcomes: for example, Borendal Wodlin et al. (2011c) used quality-of-life measures and found that patients in the SA group reported slightly better health-related quality of life in the first postoperative month, contributing to a cost-effectiveness advantage for SA in fast-track hysterectomy. We did not capture such data, so we cannot comment on any differences in patient-perceived recovery in our cohort.

Moreover, our study did not examine incidence of postoperative complications (e.g. headaches, surgical site infection, thromboembolism) which could differ between techniques. Spinal anaesthesia can carry risks like post-dural puncture headache or transient neurological symptoms, and general anaesthesia might have respiratory complications or cognitive effects in some patients. While no major complications occurred in our groups, the study was not explicitly powered for rare events. Patient-reported outcomes (like satisfaction or pain experience) were also not measured, and these can be important when comparing anesthetic techniques. Prior research often notes higher patient satisfaction with neuraxial blocks in obstetric and some gynaecologic cases due to better pain control (Chaudhry et al., 2025; Kim et al., 2025), but this was beyond our scope.

Despite these limitations, our study contributes valuable data from a setting where open abdominal hysterectomy is still routinely performed and where anesthetic practice may need to be flexible. In many lower-resource or rural healthcare systems, the choice between GA and SA may depend on equipment availability (for GA) or provider skill (for SA). Our results are reassuring in that either approach can be employed without expecting large discrepancies in immediate recovery or safety for ASA I–II patients, as long as standard monitoring and care are in place. This evidence can help guide anesthetic planning in similar hospitals: rather than defaulting to one technique out of bias, providers can consider patient comorbidities, contraindications (e.g. spinal not suitable in coagulopathy, GA caution in severe pulmonary disease), and even patient preference (some patients may prefer to be awake or avoid a breathing tube, others may fear needles in the back) when choosing the anesthetic. The patient-centred approach is thus supported – matching the anesthetic plan to the individual case, since our findings indicate no one-size-fits-all “best” technique in terms of early recovery or stability for this patient population.

Conclusions and Future Directions

In conclusion, this study reinforces that both general and spinal anaesthesia can be viable, safe options for abdominal hysterectomy in relatively healthy patients, producing broadly similar hemodynamic and early recovery outcomes when applied within a structured perioperative care protocol. Long-held assumptions about the “instability” of spinal anaesthesia or the “stress” of general anaesthesia are increasingly tempered by evidence that outcomes depend more on how we manage the anaesthesia than which anaesthesia we choose. High-quality monitoring, prophylaxis, and ERAS principles appear to neutralize many differences, allowing anaesthesiologists to base the choice of technique on

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patient-specific and logistical factors rather than dogma.

That said, future research is needed to further clarify the nuanced effects of anesthetic modality on recovery, especially in the longer term and in specific patient subgroups. Larger multicentre trials or registries could provide the power to detect if certain outcomes (e.g. minor cognitive changes, subtle quality-of-life improvements, incidence of chronic postoperative pain) favour one technique. Moreover, investigations into immunologic and inflammatory endpoints could be enlightening. Our understanding of how anaesthesia might influence the surgical stress response at a molecular level is evolving – for instance, recent studies like Hashemian et al. (2025) showed that GA was associated with higher postoperative inflammatory cytokine levels (IL-6, TNF-α) and oxidative stress markers than SA in patients undergoing hysterectomy. Such immunological differences might have implications for wound healing or infection, and even cancer outcomes in oncologic surgery, as some studies have hypothesized (Kim et al., 2025; Žura et al., 2012). Future trials could incorporate measurements of immune function, inflammation, and stress hormones to see if the choice of anaesthesia has any meaningful impact on these pathways in the context of gynaecologic surgery.

Additionally, functional and patient-reported outcomes merit inclusion in subsequent studies. Metrics like time to ambulation unassisted, time to return to work, detailed pain and fatigue scores, and overall satisfaction or health-related quality of life (HRQoL) in the weeks after surgery would provide a more comprehensive comparison of GA vs. SA from the patient's perspective. Prior work (Borendal Wodlin et al., 2011c) suggests there may be small HRQoL benefits to spinal anaesthesia in the immediate post-discharge period, but this needs confirmation and assessment of clinical significance. It would also be valuable to examine outcomes in higher-risk patients (ASA III+ or those with significant cardiopulmonary disease) where the physiological differences might be magnified – perhaps GA could pose more respiratory risks or SA more hemodynamic challenges in those populations. Understanding if one technique confers an advantage in such subgroups will help tailor anesthetic plans to patient risk profiles.

In summary, our study supports the notion that there is no universally superior anesthetic technique for abdominal hysterectomy; both general and spinal anaesthesia can achieve excellent results. The focus should thus shift to optimizing perioperative care regardless of technique and making anesthetic choices based on individual patient needs, comorbidities, and resource context. Ongoing research, especially large-scale and long-term studies, will further illuminate whether any outcome differences persist in specific domains (like chronic pain or immune response) and will help refine guidelines for anesthetic selection. Until then, anaesthesiologists should feel empowered to use either GA or SA for hysterectomy in appropriate candidates, knowing that with vigilant care, patient safety and early recovery will not be compromised by the choice of one over the other.

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