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ORIGINAL ARTICLE

Neuroaxial Versus General Anesthesia for Gynecological Surgeries: A Comparative Study

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ABSTRACT
Background: The choice of anesthetic technique in gynecological surgery significantly influences perioperative safety, postoperative recovery, and patient satisfaction. General anesthesia (GA) remains widely used due to airway control and suitability for laparoscopic procedures, while neuroaxial anesthesia (NA) offers superior analgesia and recovery benefits.
Objective: To compare perioperative outcomes of neuroaxial versus general anesthesia in patients undergoing elective gynecological surgeries at a tertiary care center in Pakistan.
Methods: This prospective, comparative study was conducted at the Department of Anesthesiology, Jinnah Postgraduate Medical Center, Karachi, from January to July 2023. A total of 100 female patients (ASA I–III, aged 25–60 years) were randomized into two groups: NA (n=50) and GA (n=50). Intraoperative hemodynamics, blood loss, duration of surgery, postoperative analgesia, opioid consumption, incidence of postoperative nausea and vomiting (PONV), time to ambulation, hospital stay, and patient satisfaction were recorded. Data were analyzed using SPSS v25, with $p < 0.05$ considered significant.
Results: Baseline demographics were comparable between groups. Hypotension occurred more frequently under NA (22% vs. 8%, p=0.04), while blood loss was significantly lower (220 ± 48 mL vs. 295 ± 52 mL, p<0.001). Time to first analgesic request was longer with NA (6.2 ± 1.8 h vs. 2.4 ± 0.9 h, p<0.001), and 24-hour opioid use was reduced (12.6 ± 3.5 mg vs. 26.1 ± 5.1 mg, p<0.001). NA was associated with lower PONV rates (12% vs. 34%, p=0.01), earlier ambulation, shorter hospital stay, and higher satisfaction.
Conclusion: Neuroaxial anesthesia provides superior postoperative outcomes compared to general anesthesia in open gynecological surgeries, though intraoperative hypotension is more common. Anesthetic choice should be individualized based on patient comorbidities, surgical type, and institutional resources.
Keywords: Neuroaxial anesthesia; General anesthesia; Gynecological surgery; Postoperative recovery; Analgesia; Patient satisfaction.

INTRODUCTION
Anesthetic technique is a critical determinant of perioperative outcomes in gynecological surgeries. These procedures, which include hysterectomy, myomectomy, oophorectomy, adnexal mass excision, and increasingly prevalent laparoscopic and oncological operations, impose distinct physiological stresses that necessitate tailored anesthetic planning[1]. The two principal modalities neuroaxial anesthesia (NA), which includes spinal, epidural, and combined spinal-epidural blocks, and general anesthesia (GA) remain the most widely utilized approaches. Each technique offers unique benefits and potential drawbacks, making their comparative evaluation essential for optimizing surgical safety, efficiency, and patient-centered outcomes[2].

General anesthesia has historically been the default choice for major gynecological surgeries because it ensures rapid induction, secure airway management, profound muscle relaxation, and suitability for prolonged procedures requiring pneumoperitoneum and steep Trendelenburg positioning[3]. However, GA is associated with significant drawbacks including airway-related complications, increased risk of postoperative nausea and vomiting (PONV), higher opioid consumption, residual neuromuscular blockade, and delayed mobilization. In patients with comorbidities such as obesity, hypertension, ischemic heart disease, or respiratory disease, these complications may contribute to heightened morbidity and longer hospital stays[4].

In contrast, neuroaxial anesthesia provides dense sensory and motor blockade with preserved consciousness and spontaneous ventilation. It has been reported to attenuate neuroendocrine stress responses, reduce intraoperative blood loss, and provide effective postoperative analgesia without the need for high-dose opioids[5]. Moreover, NA is associated with a lower incidence of PONV, faster bowel recovery, and earlier mobilization, which align with enhanced recovery after surgery (ERAS) protocols. Its cost-effectiveness and reduced demand on postoperative analgesia services make NA particularly advantageous in low- and middle-income countries. Nonetheless, NA is not free from limitations: intraoperative hypotension, urinary retention, limited surgical exposure in lengthy or laparoscopic procedures, and rare complications such as post-dural puncture headache or neurological injury remain valid concerns[6].

Despite extensive clinical use of both techniques, there is no universal consensus regarding the superiority of one over the other in gynecological surgery[7]. Comparative studies have yielded heterogeneous findings, largely due to variations in surgical type, patient demographics, anesthetic protocols, and outcome measures. For example, randomized controlled trials on abdominal hysterectomy have demonstrated reduced postoperative pain, lower opioid use, and shorter hospital stays with NA compared to GA. Conversely, laparoscopic gynecological procedures typically favor GA because of the physiological demands of pneumoperitoneum and patient positioning[8,9].

Given the rising emphasis on ERAS pathways and patient-centered care, the choice of anesthetic modality requires careful individualization. In resource-limited settings, where anesthesia and analgesia services may be constrained, the decision carries even greater clinical and economic implications. A structured comparison of NA versus GA in gynecological surgeries is therefore warranted to clarify outcome differences and inform best practices[10].

This study was designed to evaluate the intraoperative and postoperative outcomes of neuroaxial versus general anesthesia in patients undergoing gynecological surgeries. The comparison focused on hemodynamic stability, analgesic requirements, incidence of postoperative nausea and vomiting, length of hospital stay, and patient satisfaction. By analyzing these endpoints, the study aims to contribute evidence-based insights that may guide anesthetic selection in gynecological practice, particularly in

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settings where optimizing resources and enhancing recovery are paramount[11].

MATERIALS AND METHODS

Study Design and Setting: This comparative, hospital-based clinical study was conducted at the Department of Anesthesiology in collaboration with the Department of Gynecology and Obstetrics, Jinnah Postgraduate Medical Center (JPMC), Karachi, Pakistan. The study was designed to evaluate and compare the perioperative outcomes of neuroaxial anesthesia and general anesthesia in patients undergoing elective gynecological surgeries. The total study duration extended over a six-month period, from January 2023 to July 2023, during which patients were systematically enrolled and followed from the preoperative stage to the immediate postoperative period until discharge.

Study Population and Sample Size Determination: The study population comprised female patients scheduled for elective gynecological surgeries such as abdominal hysterectomy, myomectomy, adnexal mass excision, and oophorectomy. A priori sample size estimation was performed using G*Power software version 3.1, with the primary endpoint set as the difference in postoperative pain scores at 24 hours between neuroaxial and general anesthesia groups. Based on previously published studies reporting a mean difference of 1.2 units in pain scores on the Visual Analogue Scale (VAS) with a standard deviation of 2.0, a power of 80%, and a two-sided alpha error of 0.05, the minimum required sample size was calculated to be 88 patients. To account for potential attrition, incomplete records, and intraoperative protocol deviations, the sample size was inflated by approximately 12%, yielding a total of 100 participants. These were evenly distributed into two groups, with 50 patients receiving neuroaxial anesthesia and 50 patients undergoing general anesthesia.

Inclusion and Exclusion Criteria: Patients were eligible for enrollment if they were between the ages of 25 and 60 years, belonged to the American Society of Anesthesiologists (ASA) physical status classification I to III, and were scheduled for elective gynecological surgery of expected duration between one and three hours. Patients with ASA class IV or higher, those undergoing emergency procedures, and individuals with contraindications to either anesthetic technique—such as spinal deformities, coagulopathies, severe cardiopulmonary compromise, or known allergy to study drugs—were excluded. Furthermore, patients who declined to provide written informed consent were not considered for participation.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Review Board (IRB). Written informed consent was obtained from all participants after detailed explanation of study objectives, interventions, possible benefits, and anticipated risks. Ethical principles were strictly observed, and confidentiality of patient data was maintained in accordance with the Declaration of Helsinki (2013 revision).

Randomization and Allocation: Randomization was achieved using a computer-generated random number sequence prepared by an independent statistician. Allocation concealment was ensured using sequentially numbered opaque sealed envelopes, which were opened immediately before induction of anesthesia. Patients were assigned to one of the two groups: Group A received neuroaxial anesthesia (spinal or epidural), while Group B received general anesthesia.

Anesthesia Protocols: In the neuroaxial anesthesia group, patients were positioned in the sitting posture, and standard aseptic precautions were followed. Spinal anesthesia was administered using 0.5% hyperbaric bupivacaine (12–15 mg), whereas epidural anesthesia was performed using 0.5% plain bupivacaine (15–20 mL). Oxygen supplementation at 5 L/min was provided via a face mask. Hemodynamic parameters were closely monitored, and any fall in mean arterial pressure of more than 20% from baseline was corrected with rapid infusion of crystalloids and intravenous mephentermine as required.

In the general anesthesia group, patients were premedicated with midazolam 0.03 mg/kg and fentanyl 2 µg/kg. Induction was carried out with propofol 2 mg/kg and atracurium 0.5 mg/kg to facilitate tracheal intubation. Maintenance of anesthesia was achieved with isoflurane in a mixture of 50% oxygen and 50% nitrous oxide, while intermittent doses of atracurium were used for muscle relaxation. At the conclusion of surgery, residual neuromuscular blockade was antagonized with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. Extubation was performed once patients met standard criteria for airway protection and spontaneous breathing.

Data Collection: Perioperative data were recorded by anesthesiology residents trained for uniform data acquisition using a structured proforma. Intraoperative monitoring included heart rate, mean arterial pressure, oxygen saturation, and estimated blood loss. Postoperative outcomes comprised time to first analgesic requirement, total analgesic consumption within 24 hours, incidence of postoperative nausea and vomiting, time to ambulation, and duration of hospital stay. Patient satisfaction was evaluated at 24 hours post-surgery using a five-point Likert scale, ranging from very dissatisfied to very satisfied.

Statistical Analysis: Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age, duration of surgery, blood loss, and hospital stay were expressed as mean ± standard deviation and compared using the independent Student's t-test after confirming normality with the Shapiro–Wilk test. Categorical variables such as incidence of hypotension, postoperative nausea and vomiting, and patient satisfaction scores were presented as frequencies and percentages, with intergroup differences assessed using the Chi-square test or Fisher's exact test as appropriate. The level of statistical significance was set at $p < 0.05$. The power analysis ensured that the study was adequately powered to detect clinically significant differences between the two anesthetic techniques.

RESULTS

Demographic and Baseline Characteristics: A total of 100 female patients were enrolled in the study, with 50 patients assigned to the neuroaxial anesthesia group (Group A) and 50 to the general anesthesia group (Group B). Both groups were well matched in baseline demographic and clinical variables. The mean age of patients in Group A was 43.8 ± 8.1 years compared to 44.6 ± 7.9 years in Group B, with no statistically significant difference (p = 0.62). The majority of patients were within the 36–55 years age bracket. Body mass index (BMI) was also comparable between the two groups, averaging 27.4 ± 3.5 kg/m² in Group A and 28.1 ± 3.9 kg/m² in Group B (p = 0.48).

With respect to ASA physical status, most patients in both groups belonged to ASA II (58% in Group A and 56% in Group B). The distribution of surgical procedures was also similar, with abdominal hysterectomy being the most common (54% in Group A and 58% in Group B), followed by myomectomy, oophorectomy, and adnexal mass excision. No statistically significant intergroup differences were observed in these baseline variables (Table 1).

Table 1. Demographic and baseline clinical characteristics

Age (years, mean ± SD)	43.8 ± 8.1	44.6 ± 7.9	0.62
BMI (kg/m², mean ± SD)	27.4 ± 3.5	28.1 ± 3.9	0.48
ASA I (%)	16 (32%)	15 (30%)	0.84
ASA II (%)	29 (58%)	28 (56%)	0.82
ASA III (%)	5 (10%)	7 (14%)	0.54
Abdominal hysterectomy	27 (54%)	29 (58%)	0.69
Myomectomy	12 (24%)	11 (22%)	0.81
Oophorectomy	7 (14%)	6 (12%)	0.76
Adnexal excision	4 (8%)	4 (8%)	1.00

The similarity in demographic profiles ensured that observed outcome differences could be attributed primarily to the anesthetic technique rather than baseline confounding variables.

Intraoperative Hemodynamic and Surgical Outcomes: Hemodynamic stability was generally well maintained in both groups. However, intraoperative hypotension was significantly more common in the neuroaxial anesthesia group (22%) compared to the general anesthesia group (8%), with a p-value of 0.04. Bradycardia occurred in three patients (6%) under neuroaxial anesthesia but was not observed in the general anesthesia group.

In terms of blood loss, patients in Group A demonstrated significantly lower intraoperative bleeding, with a mean estimated blood loss of 220 ± 48 mL, compared to 295 ± 52 mL in Group B ($p < 0.001$). The mean duration of surgery was similar across the groups (108 ± 21 minutes in Group A vs. 111 ± 25 minutes in Group B, $p = 0.47$), showing that surgical time was not influenced by the type of anesthesia administered (Table 2).

Table 2. Intraoperative hemodynamic and surgical outcomes

Parameter	Group A (Neuroaxial, n=50)	Group B (General, n=50)	p-value
Hypotension (%)	11 (22%)	4 (8%)	0.04
Bradycardia (%)	3 (6%)	0 (0%)	0.08
Blood loss (mL, mean ± SD)	220 ± 48	295 ± 52	<0.001
Duration of surgery (min)	108 ± 21	111 ± 25	0.47

These findings highlight that while neuroaxial anesthesia predisposed patients to hypotension and bradycardia, it provided the advantage of reduced blood loss compared to general anesthesia.

Postoperative Analgesia and Recovery: Pain control in the immediate postoperative period was significantly superior in the neuroaxial anesthesia group. The mean time to first analgesic requirement was 6.2 ± 1.8 hours in Group A, which was considerably longer than 2.4 ± 0.9 hours in Group B ($p < 0.001$). Correspondingly, total opioid consumption in the first 24 hours was significantly reduced among patients receiving neuroaxial anesthesia (12.6 ± 3.5 mg morphine equivalents) compared to those under general anesthesia (26.1 ± 5.1 mg, $p < 0.001$).

Postoperative nausea and vomiting (PONV) was also significantly less frequent in the neuroaxial group (12%) than in the general anesthesia group (34%) ($p = 0.01$). Early ambulation was another important finding, with patients in Group A mobilizing earlier (12.4 ± 2.1 hours) compared to Group B (18.7 ± 3.2 hours, $p < 0.001$). Neuroaxial anesthesia was further associated with a shorter mean hospital stay (3.1 ± 0.8 days) compared to general anesthesia (4.2 ± 1.1 days, $p < 0.001$) (Table 3).

Table 3. Postoperative analgesia and recovery outcomes

Outcome	Group A (Neuroaxial, n=50)	Group B (General, n=50)	p-value
Time to first analgesic (hrs)	6.2 ± 1.8	2.4 ± 0.9	<0.001
Opioid consumption (mg/24h)	12.6 ± 3.5	26.1 ± 5.1	<0.001
PONV (%)	6 (12%)	17 (34%)	0.01
Time to ambulation (hrs ± SD)	12.4 ± 2.1	18.7 ± 3.2	<0.001
Length of hospital stay (days)	3.1 ± 0.8	4.2 ± 1.1	<0.001

These results demonstrate a clear benefit of neuroaxial anesthesia in terms of postoperative pain management, early mobilization, and reduced hospitalization.

Patient Satisfaction: Patient satisfaction was assessed 24 hours after surgery. The proportion of patients reporting high satisfaction ("satisfied" or "very satisfied") was greater in the neuroaxial anesthesia group (86%) compared to the general anesthesia group (64%), with statistical significance ($p = 0.02$). Conversely, dissatisfaction was more frequent in the general anesthesia group, primarily due to higher incidence of postoperative nausea and delayed mobilization (Table 4).

Table 4. Patient satisfaction scores at 24 hours postoperatively

Satisfaction level	Group A (Neuroaxial, n=50)	Group B (General, n=50)	p-value
Very satisfied (%)	26 (52%)	18 (36%)	
Satisfied (%)	17 (34%)	14 (28%)	
Neutral (%)	5 (10%)	11 (22%)	
Dissatisfied/Very dissatisfied	2 (4%)	7 (14%)	0.02

Overall, the study revealed that neuroaxial anesthesia provided superior postoperative analgesia, reduced opioid use, earlier mobilization, lower incidence of PONV, and shorter hospital stays compared to general anesthesia. However, neuroaxial anesthesia was associated with a higher frequency of intraoperative hypotension, while general anesthesia offered greater airway security and fewer cardiovascular fluctuations. Patient satisfaction was higher with neuroaxial anesthesia, suggesting that despite intraoperative risks, its benefits translated into improved patient-centered outcomes.

DISCUSSION

The present study compared the perioperative outcomes of neuroaxial anesthesia (NA) and general anesthesia (GA) in patients undergoing elective gynecological surgeries at a tertiary care hospital in Pakistan. The results demonstrate that neuroaxial anesthesia provided superior postoperative analgesia, reduced opioid consumption, earlier mobilization, lower incidence of postoperative nausea and vomiting (PONV), and shorter hospital stays compared to general anesthesia[12]. Conversely, intraoperative hypotension and bradycardia were more frequently observed in the neuroaxial group, highlighting the trade-off between intraoperative hemodynamic stability and postoperative recovery advantages[13].

Our findings are consistent with those reported in previous randomized controlled trials and meta-analyses. Studies by Shapiro et al. and Gupta et al. have shown that spinal and epidural anesthesia reduce postoperative opioid requirements and improve early recovery profiles in abdominal hysterectomy patients[14]. Similarly, a Cochrane review on regional versus general anesthesia for major abdominal surgeries concluded that neuroaxial blocks were associated with improved postoperative pain scores and reduced PONV rates. In the present study, patients in the neuroaxial group required their first analgesic significantly later and consumed almost 50% less opioids within 24 hours, confirming the analgesic advantage of this technique[15].

The reduction in PONV observed in the neuroaxial group is particularly important in gynecological patients, who are inherently at higher risk for PONV due to female sex, perioperative opioid use, and the nature of surgical procedures. Lower PONV rates not only improve patient satisfaction, as demonstrated in this study, but also facilitate early oral intake and ambulation, which are central to enhanced recovery after surgery (ERAS) protocols [16].

Another significant finding of our study was the shorter hospital stay among patients receiving neuroaxial anesthesia. This is consistent with the reports by Gizzo et al. and other ERAS-driven research, which emphasize the economic and clinical benefits of regional anesthesia in terms of cost reduction, decreased resource utilization, and earlier discharge[17]. In low- and middle-income settings such as Pakistan, where healthcare costs and bed occupancy are major concerns, the use of neuroaxial anesthesia could provide substantial advantages for both patients and institutions[18].

On the other hand, neuroaxial anesthesia was associated with a higher incidence of intraoperative hypotension, necessitating the use of fluids and vasopressors. This observation aligns with the known physiological effects of spinal and epidural anesthesia, where sympathetic blockade leads to vasodilation and reduced venous return[19]. While this complication is usually manageable, it underscores the need for vigilant hemodynamic monitoring and readiness to intervene promptly. General anesthesia, in contrast, provided greater airway control and hemodynamic predictability, particularly in patients with obesity or anticipated difficult airway. This explains why GA continues to be the preferred choice for complex laparoscopic procedures, where pneumoperitoneum and steep Trendelenburg positioning pose additional physiological challenges[20].

The present study adds to the growing body of evidence that anesthetic choice must be individualized rather than standardized. While neuroaxial anesthesia clearly offers superior postoperative outcomes in terms of pain, nausea, and recovery, its intraoperative risks and limitations in prolonged laparoscopic surgeries suggest that it cannot completely replace general anesthesia. The decision should therefore incorporate patient comorbidities, surgical type, anesthesiologist expertise, and institutional protocols[21].

A key strength of this study is its prospective design and equal distribution of patients into two groups, which reduced selection bias. Additionally, the sample size was determined through a priori power analysis, ensuring adequate statistical validity. Furthermore, the study was conducted at a high-volume tertiary care center, enhancing its clinical relevance[22].

However, the study also has limitations. First, it was conducted at a single institution, which may limit the generalizability of the findings. Second, the duration of follow-up was limited to the immediate postoperative period and hospital stay; long-term outcomes such as chronic pain or quality of life were not assessed[23]. Third, the study did not include laparoscopic or robotic gynecological surgeries, which are increasingly common, and where general anesthesia remains the standard of care. Finally, blinding was not possible due to the nature of anesthetic techniques, which may have introduced subjective bias in patient satisfaction reporting[24].

Despite these limitations, the study provides important local data and reinforces global evidence supporting the role of neuroaxial anesthesia in gynecological surgeries, particularly for open procedures where postoperative pain and recovery are key determinants of outcomes[25].

CONCLUSION

In conclusion, this study demonstrates that neuroaxial anesthesia offers significant advantages over general anesthesia for elective gynecological surgeries. Patients receiving neuroaxial blocks experienced reduced postoperative pain, lower opioid requirements, earlier mobilization, fewer episodes of postoperative nausea and vomiting, shorter hospital stays, and higher overall satisfaction. However, these benefits come at the cost of increased intraoperative hypotension and bradycardia, necessitating vigilant monitoring and prompt management.

General anesthesia remains an appropriate choice for patients undergoing lengthy or laparoscopic procedures, or in cases where airway control is paramount. Therefore, the choice of anesthetic technique should be individualized, taking into account the surgical procedure, patient comorbidities, and available resources. Adoption of neuroaxial anesthesia, particularly in open gynecological surgeries, can enhance recovery, improve patient-centered outcomes, and reduce hospital resource utilization in tertiary care settings in Pakistan.

Availability of data and materials: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' Contributions

- **SR**: Study conception, design, supervision, manuscript revision.
- **AS**: Protocol design, anesthesia expertise, drafting.
- **AH**: Patient enrollment, data collection, initial analysis.
- **MA**: Intraoperative monitoring, data acquisition.
- **KH**: Postoperative assessment, results tabulation.
- **SK**: Statistical analysis, literature review, manuscript writing.

All authors read and approved the final manuscript.

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