Comparison Of Low-Dose Spinal Anaesthesia Versus Opioid-Free General Anaesthesia On Recovery Profile Following Diagnostic Hysteroscopy: A Randomized Comparative Study

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ABSTRACT

Background

Diagnostic hysteroscopy is commonly performed as an ambulatory gynaecological procedure. Rapid recovery, adequate postoperative analgesia, haemodynamic stability, and minimal adverse effects are important determinants of successful day-care anaesthesia. Opioid-free general anaesthesia (OFGA) and low-dose spinal anaesthesia (SA) are potential anaesthetic techniques for such procedures; however, comparative evidence regarding their effects on postoperative recovery remains limited. This study compared the recovery profile of OFGA and low-dose SA in patients undergoing diagnostic hysteroscopy.

Methods

This hospital-based randomized comparative study included 98 female patients aged 18–60 years with American Society of Anaesthesiologists physical status I or II who underwent elective diagnostic hysteroscopy. Patients were randomly allocated to receive OFGA (n = 49) or low-dose SA (n = 49). Recovery was assessed using the Quality of Recovery-15 (QoR-15) score at 2, 6, 10, 12, and 24 hours postoperatively. Postoperative pain was assessed using the visual analogue scale (VAS) at the same time intervals. Recovery time, adverse effects, and rescue analgesic requirements were also recorded. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test. Categorical variables were compared using the chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results

Baseline demographic characteristics, American Society of Anaesthesiologists physical status, and preoperative haemodynamic parameters were comparable between the groups. At 2 hours, the QoR-15 score was significantly higher in the OFGA group than in the low-dose SA group (9.22 ± 0.71 vs 8.82 ± 0.85; $p = 0.01$). QoR-15 scores were identical at 6, 10, 12, and 24 hours. The mean recovery time was significantly shorter in the OFGA group than in the low-dose SA group (3.63 ± 0.67 vs 5.06 ± 0.77 hours; $p < 0.001$). At 2 hours, the VAS score was significantly lower in the low-dose SA group than in the OFGA group (0.00 ± 0.00 vs 0.78 ± 0.67; $p < 0.001$). VAS scores were comparable at subsequent time points. Sore throat was significantly more frequent in the OFGA group (10.2% vs 0%; $p = 0.021$). The incidences of other adverse effects and the requirement for rescue analgesia were comparable between the groups.

Conclusion

Both OFGA and low-dose SA were effective and well tolerated for diagnostic hysteroscopy. OFGA was associated with better early recovery and a shorter recovery time, whereas low-dose SA provided superior early postoperative analgesia. The choice of anaesthetic technique should be individualized according to patient characteristics, recovery priorities, and institutional requirements.

Keywords: Diagnostic hysteroscopy; opioid-free general anaesthesia; low-dose spinal anaesthesia; quality of recovery; postoperative pain; ambulatory anaesthesia.

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INTRODUCTION

Hysteroscopy is a minimally invasive endoscopic procedure that enables direct visualization of the uterine cavity for diagnosis and minor therapeutic interventions. It is widely used for evaluating abnormal uterine bleeding, intrauterine pathology, and facilitating minor surgical procedures.[1-2] Advances in miniaturized hysteroscopes and imaging optics have made hysteroscopy safer, faster, and increasingly suitable for outpatient settings.[3] This shift toward ambulatory management requires anaesthetic techniques that ensure rapid recovery, early ambulation, minimal complications, and safe same day discharge.[4]

Anaesthetic options for hysteroscopy include local anaesthesia with sedation, regional anaesthesia, and general anaesthesia. While general anaesthesia provides controlled surgical conditions, opioid-based techniques are associated with postoperative nausea and vomiting (PONV), respiratory depression, sedation, and delayed recovery.[5-7] To overcome these limitations, opioid-sparing and opioid-free anaesthesia (OFA) strategies have gained prominence in ambulatory surgery. OFA employs multimodal non-opioid agents such as ketamine, lidocaine, paracetamol, NSAIDs, and magnesium, offering analgesia and haemodynamic stability with reduced opioid-related adverse effects. Clinical studies demonstrate improved recovery quality, reduced PONV, and faster discharge readiness with OFA.[8]

Anaesthetic Considerations

The choice of anaesthesia in diagnostic hysteroscopy must balance patient comfort, analgesia, and rapid recovery.

- Local anaesthesia with sedation: Paracervical block or topical cervical anaesthesia combined with light sedation is effective for brief procedures but may be inadequate for extensive uterine manipulation.[9]
- Monitored anaesthesia care: Provides anxiolysis and analgesia but opioid use increases risk of PONV and respiratory depression.[6,8]
- Low-dose spinal anaesthesia: Offers dense sensory blockade with minimal systemic exposure, reduced sedation, and avoidance of airway instrumentation. Risks include hypotension, urinary retention, and post-dural puncture headache.[9-11]
- General anaesthesia: Ensures controlled airway and predictable surgical conditions but conventional opioid-based GA prolongs recovery and increases adverse effects.[10]

Enhanced Recovery After Surgery (ERAS) protocols emphasize rapid recovery, early ambulation, and minimal postoperative complications. Tools such as the modified Aldrete score and Quality of Recovery-15 (QoR-15) provide validated measures of recovery, including physical comfort, pain, emotional state, and independence.[11]

Opioid-Free Anaesthesia and Regional Techniques

OFA has emerged as a promising alternative in ambulatory gynaecological procedures. Intravenous lidocaine, ketamine infusion, NSAIDs, and paracetamol provide effective analgesia while reducing opioid consumption.[12-14] Randomized trials in hysteroscopy show that OFA reduces PONV and improves QoR scores compared with conventional GA.[13,14]

Low-dose spinal anaesthesia is another viable option, offering effective analgesia with reduced systemic drug exposure.[9,11,15] Compared with GA, it minimizes sedation and airway manipulation, potentially enhancing recovery. However, risks such as urinary retention and haemodynamic fluctuations require careful monitoring.[10,15]

Recent studies suggest both OFA and low-dose spinal anaesthesia improve recovery compared with opioid-based GA. Yet, direct comparative evidence between these two techniques in diagnostic hysteroscopy remains limited.[16-18]

MATERIALS AND METHODS

2.1 Study design and setting

This was a prospective, hospital-based randomized comparative study conducted in the Department of Anaesthesiology at the National Institute of Medical Sciences and Research Hospital, Jaipur, Rajasthan, India. The study was conducted over 18 months, from July 2024 to December 2025, after approval from the institutional ethics committee.

2.2 Study population

Female patients aged 18–60 years with American Society of Anesthesiologists (ASA) physical status I or

II who were scheduled to undergo elective diagnostic hysteroscopy were included in the study.

Inclusion criteria

- Female patients aged 18–60 years
- ASA physical status I or II
- Patients providing written informed consent

Exclusion criteria

- ASA physical status III or IV
- History of anaphylaxis or hypersensitivity to the study drugs
- History of chronic pain or chronic opioid use
- Bleeding disorders or coagulopathy

2.3 Sample size

The sample size was calculated using the difference in mean quality-of-recovery scores reported in the reference study. With a confidence level of 95% and study power of 80%, the calculated sample size was approximately 49 patients per group. Therefore, a total of 98 participants were included.

$$(n) = 2*(Z\alpha/2 + Z1-\beta)2 * (\sigma1\ 2 + \sigma2\ 2) \quad (\mu2-\mu1)2$$

$$= 2* (1.96+0.84)\ ^{2} * (6.22+ 5.32) \quad (172.6-177.2)2$$

$$= 49.3 \approx 49 \text{ samples/group}$$

2.4 Randomization and allocation

Patients were randomly allocated in a 1:1 ratio to one of the two study groups using computer-generated random numbers. The allocation sequence was placed in sequentially numbered opaque envelopes. The envelope was opened before shifting the patient to the operating room, and the patient was allocated to the corresponding study group.

The study groups were:

- Group A: Opioid-free general anaesthesia (OFGA), n = 49
- Group B: Low-dose spinal anaesthesia (SA), n = 49

2.5 Preoperative assessment

All patients underwent a detailed pre anaesthetic evaluation. Baseline haemodynamic parameters, including systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, peripheral oxygen saturation, and respiratory rate, were recorded. Routine investigations were performed according to institutional protocol and clinical indication. Written informed consent was obtained from all participants.

2.6 Anaesthetic technique

2.6.1 Opioid-free general anaesthesia group

After confirming fasting status, standard monitoring, including electrocardiography, non-invasive blood pressure monitoring, and pulse oximetry, was instituted. Intravenous access was established, and crystalloid infusion was started.

Pre-oxygenation done for 3-5 minutes with 10L/min oxygen before induction. Induction was achieved with propofol 2 mg/kg IV or ketamine 1 to 2 mg/kg. After loss of consciousness, ventilation was assisted. Neuromuscular blockade was achieved with succinylcholine or atracurium besylate 0.5 mg/kg IV. Airway secured with appropriately sized LMA[I-gel]. Ventilation maintained using closed circuit and mechanical ventilator. End-tidal capnometry and anaesthetic gas monitoring were used. Paracetamol 15-20mg/kg given for pain management. Additional doses of atracurium 0.1mg/kg were given as needed. Ondansetron was given before the end of surgery. Anaesthetic was discontinued just before completion of procedure. Neuromuscular block was reversed with glycopyrrolate 0.008 mg/kg and neostigmine 0.05 mg/kg IV.

2.6.2 Low-dose spinal anaesthesia group

Standard monitoring was applied, baseline haemodynamic parameters were recorded, and intravenous access was established. Subarachnoid block was performed using a 25-gauge spinal needle at L3–L4 or L4–L5 space. After confirmation of CSF flow, 1.5–2 ml [7.5-10mg] of 0.5% hyperbaric bupivacaine was injected. Patients were placed supine with 15° tilt to achieve desired block level.

2.7 Outcome measures

Primary outcomes

The primary outcomes were:

1. Quality of Recovery-15 (QoR-15) score
2. Haemodynamic parameters
3. Time taken for recovery

QoR-15 scores were assessed at 2, 6, 10, 12, and 24 hours postoperatively.

Secondary outcomes

The secondary outcomes were:

1. Postoperative pain assessed using the visual analogue scale (VAS)
2. Incidence of postoperative adverse effects
3. Requirement for rescue analgesia

VAS scores were recorded at 2, 6, 10, 12, and 24 hours postoperatively. Adverse effects, including nausea, vomiting, headache, sore throat, and urinary retention, were recorded. The requirement for rescue analgesia was also documented.

2.8 Statistical analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences software. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-

test. Categorical variables were expressed as frequency and percentage and compared using the chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 98 patients were included in the study. Forty-nine patients received OFGA and 49 patients received low-dose SA.

3.1 Baseline characteristics

The mean age was 35.67 ± 8.44 years in the OFGA group and 32.49 ± 8.43 years in the low-dose SA group. The difference was not statistically significant (p = 0.065).

The distribution of ASA physical status was comparable between the groups. In the OFGA group, 31 patients (63.3%) were classified as ASA I and 18 patients (36.7%) as ASA II. In the low-dose SA group, 34 patients (69.4%) were ASA I and 15 patients (30.6%) were ASA II. The difference was not statistically significant (p = 0.516).

Table 1. Comparison of baseline characteristics

Characteristic	OFGA (n = 49)	Low-dose SA (n = 49)	*p*-value
Age, years	35.67 ± 8.44	32.49 ± 8.43	0.065
ASA I, n (%)	31 (63.3)	34 (69.4)	0.516
ASA II, n (%)	18 (36.7)	15 (30.6)	

3.2 Preoperative haemodynamic parameters

Preoperative systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, peripheral oxygen saturation, and respiratory rate were comparable between the two groups.

Table 2. Comparison of preoperative haemodynamic parameters

Parameter	OFGA	Low-dose SA	*p*-value
Systolic blood pressure, mmHg	117.90 ± 8.89	118.14 ± 9.00	0.88
Diastolic blood pressure, mmHg	74.45 ± 5.37	74.31 ± 6.83	0.91
Mean arterial pressure, mmHg	88.86 ± 6.06	88.98 ± 7.36	0.93
Heart rate, beats/min	80.00 ± 4.65	80.29 ± 5.69	0.78
Peripheral oxygen saturation, %	99.43 ± 0.87	99.45 ± 0.75	0.89
Respiratory rate, breaths/min	14.02 ± 1.29	14.14 ± 1.46	0.72

3.3 Quality of Recovery-15 scores

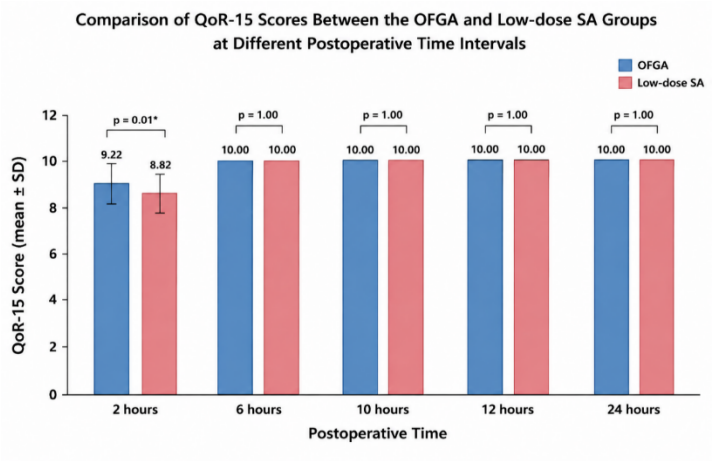
At 2 hours postoperatively, the mean QoR-15 score was significantly higher in the OFGA group than in the low-dose SA group (9.22 ± 0.71 vs 8.82 ± 0.85; p = 0.01).

At 6 hours, both groups had a mean QoR-15 score of 10.00 ± 0.00. The QoR-15 scores remained identical at 10, 12, and 24 hours, with no statistically significant difference between the groups.

Table 3. Comparison of Quality of Recovery-15 scores

Postoperative time	OFGA	Low-dose SA	*p*-value
2 hours	9.22 ± 0.71	8.82 ± 0.85	0.01*
6 hours	10.00 ± 0.00	10.00 ± 0.00	1.00
10 hours	10.00 ± 0.00	10.00 ± 0.00	1.00
12 hours	10.00 ± 0.00	10.00 ± 0.00	1.00
24 hours	10.00 ± 0.00	10.00 ± 0.00	1.00

*Statistically significant, p < 0.05.



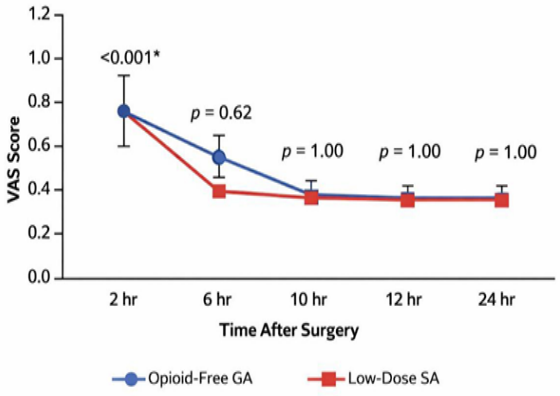
3.4 Postoperative pain scores

At 2 hours postoperatively, the mean VAS score was significantly lower in the low-dose SA group than in the OFGA group (0.00 ± 0.00 vs 0.78 ± 0.67; p < 0.001).
At 6 hours, the mean VAS score was 1.20 ± 0.40 in the OFGA group and 1.15 ± 0.35 in the low-dose SA group. The difference was not statistically significant (p = 0.62).
At 10, 12, and 24 hours, the VAS score was 0.00 ± 0.00 in both groups.

Table 4. Comparison of postoperative VAS scores

Postoperative time	OFGA	Low-dose SA	*p*-value
2 hours	0.78 ± 0.67	0.00 ± 0.00	<0.001*
6 hours	1.20 ± 0.40	1.15 ± 0.35	0.62
10 hours	0.00 ± 0.00	0.00 ± 0.00	1.00
12 hours	0.00 ± 0.00	0.00 ± 0.00	1.00
24 hours	0.00 ± 0.00	0.00 ± 0.00	1.00

*Statistically significant, p < 0.05.

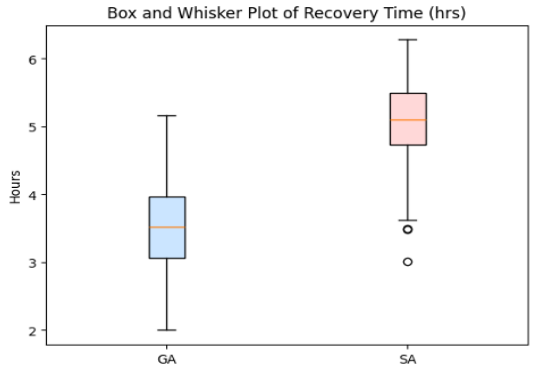


3.5 Recovery time
The mean time taken for recovery was significantly shorter in the OFGA group than in the low-dose SA group (3.63 ± 0.67 vs 5.06 ± 0.77 hours; p < 0.001).

Table 5. Comparison of recovery time

Outcome	OFGA	Low-dose SA	*p*-value
Recovery time, hours	3.63 ± 0.67	5.06 ± 0.77	<0.001*

*Statistically significant, p < 0.05.

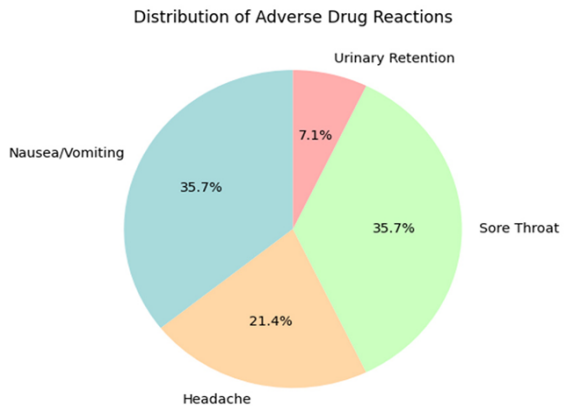


3.6 Postoperative adverse effects
Nausea or vomiting occurred in 2 patients (4.1%) in the OFGA group and 3 patients (6.1%) in the low-dose SA group. The difference was not statistically significant (p = 0.648).
Headache occurred in 1 patient (2.0%) in the OFGA group and 2 patients (4.1%) in the low-dose SA group, with no statistically significant difference (p = 0.559).
Sore throat occurred in 5 patients (10.2%) in the OFGA group and in no patients in the low-dose SA group. The difference was statistically significant (p = 0.021).
Urinary retention occurred in 1 patient (2.0%) in the low-dose SA group and in no patient in the OFGA group. The difference was not statistically significant (p = 0.314).

Table 6. Comparison of postoperative adverse effects

Adverse effect	OFGA, n (%)	Low-dose SA, n (%)	*p*-value
Nausea/vomiting	2 (4.1)	3 (6.1)	0.648
Headache	1 (2.0)	2 (4.1)	0.559
Sore throat	5 (10.2)	0 (0)	0.021*
Urinary retention	0 (0)	1 (2.0)	0.314

*Statistically significant, p < 0.05.



3.7 Rescue analgesic requirement

Rescue analgesia with paracetamol was required by 8 patients (16.3%) in the OFGA group and 5 patients (10.2%) in the low-dose SA group. The difference was not statistically significant (p = 0.372).

Table 7. Comparison of rescue analgesic requirement

Rescue analgesia	**OFGA, n (%)**	**Low-dose SA, n (%)**	***p*-value**
Required	**8 (16.3)**	**5 (10.2)**	**0.372**
Not required	**41 (83.7)**	**44 (89.8)**	

DISCUSSION

Discussion

The present study compared the recovery profile of low-dose spinal anaesthesia (SA) and opioid-free general anaesthesia (OFGA) in patients undergoing diagnostic hysteroscopy. Both techniques provided satisfactory perioperative outcomes. The groups were comparable with respect to age, ASA physical status, and baseline haemodynamic parameters, allowing a balanced comparison of postoperative outcomes. At 2 hours postoperatively, the QoR-15 score was significantly higher in the OFGA group than in the low-dose SA group. However, the scores were identical from 6 to 24 hours, indicating that the observed advantage of OFGA was limited to the early postoperative period. The better early recovery with OFGA may be related to the absence of residual neuraxial motor and sensory blockade and the rapid recovery profile of intravenous anaesthetic agents. Enhanced recovery pathways emphasize the importance of minimizing perioperative stress and facilitating early functional recovery, particularly in ambulatory surgery.[19–21]

In contrast, low-dose SA provided superior immediate postoperative analgesia. The VAS score at 2 hours was significantly lower in the SA group, while pain scores were comparable at subsequent time points. The improved early analgesia with SA may be attributed to the continued sensory blockade produced by intrathecal local anaesthetic. Although the requirement for rescue analgesia was numerically higher in the OFGA group, the difference was not statistically significant. These findings suggest a clinical trade-off between faster early recovery with OFGA and better immediate analgesia with low-dose SA.[22–24]

Recovery time was significantly shorter in the OFGA group. The absence of residual motor blockade and earlier restoration of mobility may explain this finding. Faster recovery may be advantageous in high-volume day-care settings, where early ambulation and efficient patient turnover are important. Previous studies of ambulatory anaesthesia have similarly emphasized the role of anaesthetic techniques that facilitate early recovery and discharge readiness.[19,25]

The incidence of postoperative adverse effects was low in both groups. Sore throat was significantly more frequent in the OFGA group, likely because of airway instrumentation. Nausea, vomiting, and headache were comparable between groups. Urinary retention occurred only in the low-dose SA group, although the difference was not statistically significant. These findings are consistent with the differing adverse-effect profiles of general and neuraxial anaesthesia.[26] Both techniques also maintained satisfactory haemodynamic stability, which may be attributable to appropriate patient selection and the use of low-dose intrathecal local anaesthetic in the SA group and multimodal non-opioid agents in the OFGA group.

Overall, both OFGA and low-dose SA were effective and well tolerated for diagnostic hysteroscopy. OFGA was associated with better early recovery and a shorter recovery time, whereas low-dose SA provided superior immediate postoperative analgesia. Therefore, the choice of technique should be individualized according to the desired balance between rapid recovery, early analgesia, patient characteristics, and institutional requirements.

STRENGTHS AND LIMITATIONS

Strengths :

The randomized comparative design was a strength of the study and reduced the possibility of selection-related bias. The inclusion of a relatively uniform population of ASA I–II patients undergoing the same surgical procedure improved comparability between the groups. The study evaluated several clinically relevant outcomes, including recovery score, postoperative pain,

recovery time, adverse effects, and rescue analgesic requirement.

Limitations :

The study also had limitations. First, it was conducted at a single institution, which may limit the generalizability of the findings. Second, the sample size may not have been sufficient to identify differences in uncommon adverse events. Third, only ASA I–II patients were included; therefore, the findings may not be applicable to patients with significant comorbidities. Fourth, because the two anaesthetic techniques were inherently different, complete blinding was difficult. Finally, longer-term recovery outcomes, post-discharge satisfaction, return to normal activity, and delayed complications were not evaluated.

SUMMARY

Opioid-free general anaesthesia (OFGA) uses multimodal non-opioid agents to provide analgesia while minimizing opioid-related adverse effects. Low-dose spinal anaesthesia offers effective intraoperative and early postoperative analgesia with limited systemic drug exposure but may be associated with delayed ambulation and recovery. Postoperative recovery was assessed using the patient-centred Quality of Recovery-15 (QoR-15) questionnaire.

In the present study, OFGA was associated with faster recovery, whereas low-dose spinal anaesthesia provided superior immediate postoperative analgesia. Haemodynamic parameters remained stable in both groups. The adverse-effect profiles differed, with airway-related symptoms occurring more frequently after OFGA and urinary retention occurring infrequently after spinal anaesthesia. Overall, both techniques were effective and safe for diagnostic hysteroscopy. Their differing advantages support an individualized approach based on recovery priorities, analgesic requirements, and clinical context.

CONCLUSION

Both opioid-free general anaesthesia and low-dose spinal anaesthesia were effective and well-tolerated techniques for diagnostic hysteroscopy.

Opioid-free general anaesthesia was associated with significantly better early recovery and a shorter recovery time. Low-dose spinal anaesthesia provided superior immediate postoperative analgesia. Recovery scores and pain scores were comparable between the groups at later postoperative time points.

The choice between OFGA and low-dose SA should be individualized according to patient characteristics, anticipated postoperative analgesic requirements, recovery priorities, and institutional workflow. Further multicentre studies with larger sample sizes and longer follow-up are required to confirm these findings.

Declarations

Conflict of interest:

There is no conflict of interest.

Ethical statement:

Informed consent was obtained from the patient prior to all clinical investigations and procedures. All efforts have been made to ensure patient anonymity and confidentiality.

Financial support and sponsorship:

Nil

Author contributions

Bhoi Navya: Conceptualization, study design, data collection, data analysis, interpretation of results, and manuscript preparation.

Chand Kishan Vyas: Study supervision, methodological guidance, interpretation of results, and manuscript review.

Sampat G. Rathod: Study supervision, methodological guidance, and manuscript review.

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