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A Prospective Study to Evaluate the Perioperative Management of Laparoscopy for Mild to Severe Forms of Endometriosis

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ABSTRACT

Background: *Advanced endometriosis is a complex, estrogen-dependent inflammatory condition often requiring prolonged and technically demanding laparoscopic surgery. Perioperative anaesthetic management in women with moderate to severe disease is challenging due to altered pain processing, extensive adhesions, and physiological changes associated with pneumoperitoneum. Prospective data evaluating anaesthetic characteristics, postoperative pain trajectories, and early recovery outcomes in this population remain limited.*

Methods: *This prospective observational study included 30 women aged 18–45 years with surgically confirmed revised American Society for Reproductive Medicine (rASRM) stage III–IV endometriosis undergoing elective laparoscopic surgery. All patients were classified as American Society of Anesthesiologists (ASA) physical status I–II and received a standardized general anaesthesia protocol. Intraoperative parameters, including duration of anaesthesia, pneumoperitoneum time, blood loss, and recovery time, were recorded. Postoperative pain was assessed using the Visual Analogue Scale (VAS) at predefined intervals up to 24 hours. Analgesic consumption, adverse events, and early recovery parameters were also evaluated.*

Results: *The mean age of participants was 32 ± 8.6 years, with the majority presenting with significant pain symptoms and infertility. The mean duration of anaesthesia was 125 ± 25 minutes, with minimal blood loss (65 ± 30 mL) and prompt recovery from anaesthesia (18 ± 4 minutes). Postoperative pain scores demonstrated a progressive decline from 4.8 ± 1.2 at 30 minutes to 2.1 ± 0.6 at 24 hours. Multimodal analgesia provided effective pain control, with rescue opioid analgesia required in 30% of patients. Postoperative adverse events were infrequent and mild. Early ambulation, resumption of oral intake, and short hospital stay indicated favorable early recovery outcomes.*

Conclusion: *A standardized general anaesthesia protocol combined with multimodal analgesia offers effective perioperative stability, satisfactory postoperative pain control, and rapid recovery in women undergoing laparoscopic surgery for moderate to severe endometriosis. These findings support the feasibility and safety of structured perioperative strategies in managing advanced endometriosis and highlight the need for larger studies to further refine anaesthetic and analgesic protocols in this population.*

Keywords

Endometriosis, Laparoscopy, Anesthesia, General, Postoperative Pain, Perioperative Care, Multimodal Analgesia, Pneumoperitoneum, Recovery of Function, Visual Analog Scale, Enhanced Recovery After Surgery.

Introduction

Endometriosis is a chronic, estrogen-dependent inflammatory

disorder defined by the ectopic presence of endometrial-like glands and stroma outside the uterine cavity, most commonly involving the ovaries, pelvic peritoneum, uterosacral ligaments, and, in severe cases, the bowel and urinary tract. The disease affects approximately 10–15% of women of reproductive age and represents a major cause of chronic pelvic pain, dysmenorrhoea, dyspareunia, and infertility worldwide [1,2]. Beyond its gynecological manifestations, endometriosis is increasingly recognized as a systemic condition characterized by immune dysregulation, neuroangiogenesis, and persistent inflammation, contributing to significant physical, psychological, and socioeconomic burden [3].

Disease severity is commonly classified using the revised American Society for Reproductive Medicine (rASRM) staging system. Moderate to severe endometriosis (rASRM stage III–IV) is characterized by extensive adhesions, large ovarian endometriomas, deep infiltrating lesions, and distortion of normal pelvic anatomy [4]. These advanced stages are associated with more severe pain symptoms, higher surgical complexity, and increased risk of perioperative complications. Surgical intervention, particularly laparoscopy, remains the gold standard for both diagnosis and treatment in such cases, allowing precise excision of lesions, adhesiolysis, and restoration of pelvic anatomy while offering advantages such as reduced postoperative morbidity, shorter hospital stay, and faster recovery compared with laparotomy [5,6].

However, the perioperative management of patients with advanced endometriosis poses distinct anaesthetic and surgical challenges. Laparoscopic procedures for stage III–IV disease are often prolonged and technically demanding, requiring steep Trendelenburg positioning, sustained pneumoperitoneum, and extensive dissection near vital pelvic structures [7]. These factors can significantly influence intraoperative hemodynamics, respiratory mechanics, and anaesthetic drug requirements. Carbon dioxide pneumoperitoneum is known to cause increased intra-abdominal pressure, reduced venous return, alterations in cardiac output, and changes in arterial blood gases, necessitating vigilant anaesthetic monitoring and tailored management strategies [8].

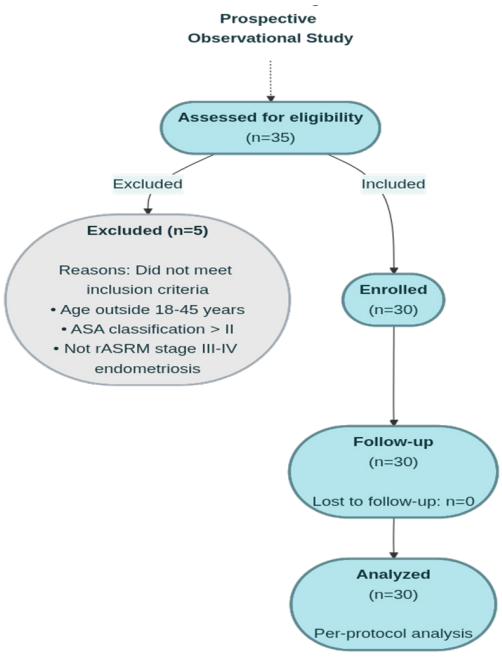
Postoperative pain management in endometriosis patients is particularly complex. Chronic pelvic pain associated with endometriosis is often driven by central sensitization, neuroinflammation, and altered pain processing pathways, which may persist even after surgical excision of lesions [9]. As a result, these patients frequently experience heightened postoperative pain, increased analgesic requirements, and delayed functional recovery compared with patients undergoing laparoscopy for other benign gynecological conditions [10]. Effective perioperative analgesia is therefore crucial, not only for immediate pain relief but also for preventing chronic postoperative pain and improving overall quality of life.

Despite the high prevalence of endometriosis and the increasing volume of laparoscopic surgeries performed for advanced disease, there remains a paucity of prospective data specifically evaluating anaesthetic characteristics, intraoperative physiological parameters, postoperative pain trajectories, and early recovery outcomes in women with rASRM stage III–IV endometriosis [11]. Most available literature focuses predominantly on surgical techniques and long-term reproductive outcomes, with limited emphasis on anaesthetic considerations and immediate postoperative recovery profiles [12].

A standardized, evidence-based perioperative approach tailored to the unique pathophysiology and surgical complexity of advanced endometriosis is essential to optimize patient safety, minimize perioperative morbidity, and enhance recovery. A better understanding of anaesthetic requirements, intraoperative trends, and postoperative analgesic responses in this specific population may inform the development of targeted perioperative protocols and multidisciplinary care pathways. Therefore, the present prospective study was undertaken to evaluate anaesthetic characteristics, intraoperative parameters, postoperative pain patterns, and early recovery outcomes in women with rASRM stage III–IV endometriosis undergoing elective laparoscopic surgery.

Methods

A prospective observational study was conducted among 30 women diagnosed with stage III–IV endometriosis and scheduled for elective laparoscopic surgery at the Medical Health and Research Institute, Hyderabad. All participants were aged between 18 and 45 years and classified as American Society of Anesthesiologists (ASA) physical status I–II. Written informed consent was obtained from all participants prior to enrolment (Flow chart 1).



Flowchart 1: Depicting screening, exclusions, enrolment, perioperative follow-up, and analysis.

All patients received a standardized general anaesthesia protocol. Premedication consisted of glycopyrrolate 0.2 mg administered intravenously. Induction of anaesthesia was achieved using midazolam 1–2.5 mg IV (slow administration), fentanyl 0.5–2 µg/kg IV, and propofol 1.5–2.5 mg/kg IV. Neuromuscular blockade for endotracheal intubation was facilitated using atracurium 0.4–0.5 mg/kg IV, administered immediately after induction.

Anaesthesia was maintained with a combination of oxygen, nitrous oxide, and isoflurane, titrated to achieve an adequate depth of anaesthesia. Intraoperative muscle relaxation was sustained with vecuronium 0.08–0.1 mg/kg IV, administered intermittently every 20–40 minutes depending on surgical requirements.

At the end of surgery, neuromuscular block was reversed using a combination of Inj Neostigmine 0.05 mg/kg + Inj Atropine 0.02 mg/kg, administered intravenously according to standard dosing guidelines.

All patients received a multimodal postoperative analgesic regimen comprising paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs). Rescue opioids were administered when pain persisted despite scheduled medications.
Postoperative pain intensity was assessed using the Visual Analogue Scale (VAS), where 0 indicated no pain and 10 indicated the worst possible pain. Pain assessments were recorded at 0.5 hours, 2 hours, 6 hours, 12 hours, and 24 hours postoperatively.

Results

A total of 30 women of reproductive age with surgically confirmed moderate to severe endometriosis (rASRM stage III–IV) were included in this prospective study. The mean age of participants was 32 ± 8.6 years, with a mean body mass index (BMI) of 24.7 kg/m². Most patients were classified as American Society of Anesthesiologists (ASA) physical status I (60%) or II (40%), indicating a low overall perioperative risk profile.

Comorbidities were infrequent, with hypertension present in 6.7%, diabetes mellitus in 3.3%, and polycystic ovary syndrome (PCOS) in 16.7% of participants. A history of prior abdominal surgery was documented in 13.3%, while 40% had received hormonal therapy before surgery.

Reproductive characteristics revealed a predominance of nulliparity (73.3%). Infertility was reported by 83.3% of patients, of whom 80% had primary infertility, with a mean infertility duration of 3.2 ± 1.8 years. Symptom burden at presentation was substantial: dysmenorrhea was reported in 93.3%, chronic pelvic pain in 80%, and dyspareunia in 66.7% of participants.

From a disease severity perspective, rASRM stage III endometriosis was more common (73.3%) than stage IV disease (26.7%). Sociodemographic analysis showed that most patients belonged to upper or lower middle socioeconomic strata (86.7%), with 60% having graduate-level education or higher. Baseline demographic, clinical, and sociodemographic characteristics are summarized in Table 1.

Table 1: Depicts the Sociodemographic and Baseline characteristics.

Characteristic	Value
Number of patients	30
Age (years), mean (SD)	32 (±8.6)
BMI (kg/m²), mean (SD)	24.7
Reproductive History	
Gravidity, mean (SD)	1.4 (1.1)
Parity Nulliparous, n (%)	 22 (73.3)
Multiparous, n (%)	8 (26.7)
Infertility history, n (%)	25 (83.3)
Primary, n (%)	20 (80.0 of infertile)
Duration, years, mean (SD)	3.2 (1.8)
Symptoms (at diagnosis) Dysmenorrhea, n (%)	 28 (93.3)
Dyspareunia, n (%)	20 (66.7)
Chronic pelvic pain, n (%)	24 (80.0)
Comorbidities & Prior Exposure Hypertension, n (%)	 2 (6.7)
Diabetes mellitus, n (%) PCOS, n (%)	1 (3.3) 5 (16.7)
Prior abdominal surgery, n (%)	4 (13.3)
Hormone therapy exposure, n (%)	12 (40.0)
Sociodemographics Education level Graduate+, n (%) Intermediate, n (%) Secondary, n (%)	 18 (60.0) 8 (26.7) 4 (13.3)
Occupation Homemaker, n (%) Professional, n (%) Others, n (%)	 14 (46.7) 10 (33.3) 6 (20.0)
Upper middle, n (%)	12 (40.0)
Lower middle, n (%)	14 (46.7)
Upper lower, n (%)	4 (13.3)
ASA I	18 (60%)
ASA II	12 (40%)
rASRM stage III, n (%)	22 (73.3%)
rASRM stage IV, n (%)	8 (26.7%)

Intraoperative Anaesthetic and Surgical Characteristics

All procedures were performed under a standardized general anaesthesia protocol, resulting in homogeneous intraoperative management across the cohort. The mean duration of anaesthesia was 125 ± 25 minutes, reflecting the moderate surgical complexity associated with advanced endometriosis. The mean pneumoperitoneum time was 80 ± 15 minutes.

Intraoperative blood loss was minimal, with a mean estimated volume of 65 ± 30 mL. Recovery from anaesthesia was prompt, with a mean recovery time of 18 ± 4 minutes, indicating stable intraoperative hemodynamics and smooth emergence from anaesthesia. Intraoperative parameters are detailed in Table 2.

Table 2: Depicts the Intraoperative Parameters.

Parameter	Mean ± SD
Duration of anaesthesia (min)	125 ± 25
Pneumoperitoneum time (min)	80 ± 15
Estimated Blood loss (mL)	65 ± 30
Recovery time (min)	18 ± 4

Postoperative Pain Outcomes

Postoperative pain intensity, assessed using the Visual Analogue Scale (VAS; range 0–10), demonstrated a consistent and progressive decline over the first 24 hours following surgery. Mean VAS scores were highest at 0.5 hours postoperatively (4.8 ± 1.2) and decreased sequentially to 4.1 ± 1.0 at 2 hours, 3.6 ± 0.9 at 6 hours, 2.9 ± 0.8 at 12 hours, and 2.1 ± 0.6 at 24 hours.

This monotonic reduction in pain scores reflects effective early postoperative pain control with the multimodal analgesic regimen. The postoperative pain profile is presented in Table 3, and the temporal pain trajectory is illustrated in Figure 2.

Table 3: Depicts the Post-operative Pain profile (VAS Scores).

Time Post-Op	Mean VAS ± SD
0.5 h	4.8 ± 1.2
2 h	4.1 ± 1.0
6 h	3.6 ± 0.9
12 h	2.9 ± 0.8
24 h	2.1 ± 0.6

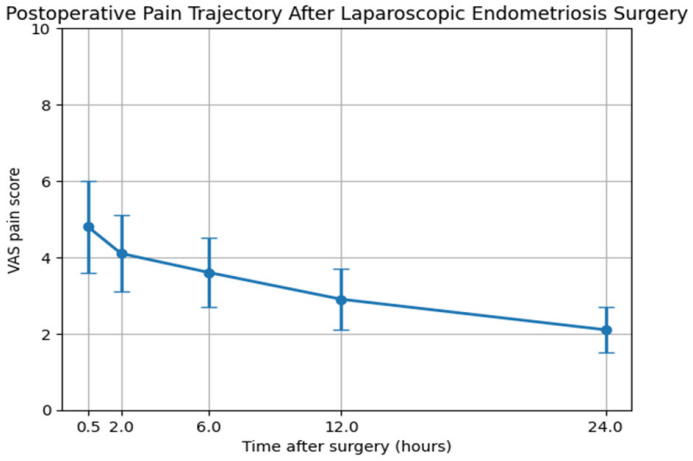


Figure 2: Postoperative Pain Trajectory Following Laparoscopic Surgery for Endometriosis.

Analgesic Consumption and Adverse Events

All patients received scheduled paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) as part of the postoperative multimodal analgesia protocol. Rescue opioid analgesia (tramadol or fentanyl) was required in 9 patients (30%) for breakthrough pain.

Postoperative adverse events were infrequent and predominantly mild. Nausea and vomiting occurred in 20% of patients, drowsiness in 10%, and transient hypotension in 6.7%. Additional antiemetic therapy was administered to 26.7% of participants. Overall, 80% of patients experienced no significant postoperative adverse events. Analgesic requirements and adverse events are summarized in Table 4, and the safety profile is depicted in Figure 3.

Table 4: Depicts Analgesic Requirements and adverse events.

Variable	Value
Paracetamol + NSAIDs (scheduled), n (%)	30 (100%)
Rescue opioid (tramadol/fentanyl), n (%)	9 (30.0%)
Additional antiemetic, n (%)	8 (26.7%)
Nausea/vomiting, n (%)	6 (20.0%)
Drowsiness, n (%)	3 (10.0%)
Transient hypotension, n (%)	2 (6.7%)
No significant adverse events, n (%)	24 (80.0%)

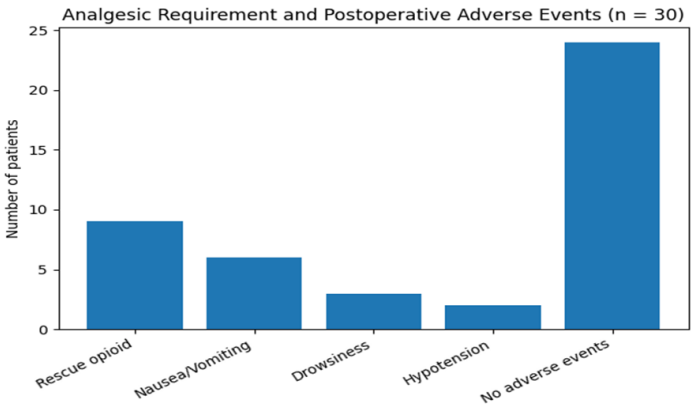


Figure 3: Recovery and Safety Profile Following Laparoscopic Endometriosis Surgery.

Bar chart depicting the incidence of rescue opioid analgesia and postoperative adverse events among study participants (n = 30). The figure 3 highlights a low requirement for rescue opioids and a favorable safety profile, with predominantly mild and self-limiting adverse events, supporting the safety and efficacy of the perioperative management protocol.

Postoperative Recovery Parameters

Early functional recovery was observed across the study cohort. The mean time to ambulation was 7.5 ± 1.8 hours, and oral intake was resumed after 8.3 ± 1.7 hours. The mean duration of hospital stay was 1.8 ± 0.5 days, reflecting rapid postoperative recovery following laparoscopic management of advanced endometriosis.

Table 5: Depicts Postoperative Recovery Parameters.

Parameter	Mean ± SD
Time to ambulation (h)	7.5 ± 1.8
Time to oral intake (h)	8.3 ± 1.7
Hospital stay (days)	1.8 ± 0.5

Discussion

This prospective observational study evaluated perioperative anaesthetic management and early postoperative outcomes in women with moderate to severe endometriosis (rASRM stage III–IV) undergoing laparoscopic surgery. The findings demonstrate

that a standardized general anaesthesia protocol combined with multimodal analgesia provides effective intraoperative stability, satisfactory postoperative pain control, and rapid functional recovery, even in patients with advanced disease complexity. These results add valuable prospective evidence to a relatively underexplored area of perioperative care in advanced endometriosis.

Advanced endometriosis presents unique perioperative challenges due to distorted pelvic anatomy, dense adhesions, prolonged operative times, and pneumoperitoneum-related physiological changes. Despite these factors, the present study observed favorable intraoperative parameters, including a mean anaesthesia duration of 125 ± 25 minutes, pneumoperitoneum time of 80 ± 15 minutes, minimal blood loss (65 ± 30 mL), and rapid recovery from anaesthesia (18 ± 4 minutes). These findings indicate effective hemodynamic control and adequate depth of anaesthesia throughout surgery.

The observed intraoperative stability aligns with contemporary recommendations emphasizing vigilant monitoring rather than routine escalation to advanced invasive strategies in elective laparoscopic procedures among ASA I–II patients [13]. Similar reviews have highlighted that balanced general anaesthesia using propofol-opioid induction and volatile agent maintenance is sufficient for maintaining cardiovascular stability during prolonged laparoscopy [14]. Our results reinforce the feasibility of such standardized protocols in surgically demanding endometriosis cases.

Postoperative pain following laparoscopic surgery for endometriosis is influenced by surgical trauma, pneumoperitoneum, and pre-existing central sensitization associated with chronic pelvic pain. In this study, postoperative VAS scores showed a consistent and monotonic decline over 24 hours, decreasing from 4.8 ± 1.2 at 30 minutes to 2.1 ± 0.6 at 24 hours. This trajectory reflects effective early pain control with the implemented multimodal analgesic regimen.

Comparable studies in laparoscopic gynecologic surgery have reported peak pain scores in the immediate postoperative period, followed by significant reductions within 24 hours when multimodal analgesia is employed [15]. The magnitude and pattern of pain reduction observed in our cohort are consistent with these findings, despite the higher baseline pain burden typically associated with advanced endometriosis. This suggests that routine use of paracetamol and NSAIDs can adequately address both nociceptive and inflammatory components of postoperative pain in this population.

Only 30% of patients in the present study required rescue opioid analgesia, which is lower than the 40–50% opioid requirement reported in some laparoscopic gynecologic series. This reduced opioid consumption may be attributed to scheduled non-opioid analgesics mitigating central sensitization and inflammatory pain pathways. A recent Bayesian network meta-analysis demonstrated that combinations of systemic non-opioid agents, particularly when integrated with regional techniques, are superior to monotherapy in reducing early postoperative opioid requirements [16].

The safety profile observed in this study was favorable, with predominantly mild and self-limiting adverse events such as nausea, drowsiness, and transient hypotension. Importantly, 80% of patients experienced no significant postoperative complications. These findings support the tolerability of the anaesthetic and analgesic regimen used and align with the growing emphasis on opioid stewardship in perioperative care.

Early ambulation (7.5 ± 1.8 hours), resumption of oral intake (8.3 ± 1.7 hours), and short hospital stay (1.8 ± 0.5 days) observed in this study reflect enhanced recovery patterns following minimally invasive surgery. Laparoscopic management of endometriosis has consistently been associated with reduced surgical morbidity and faster postoperative recovery compared with open approaches, contributing to improved quality of life and long-term pain outcomes [17].

The integration of multimodal analgesia within a standardized anaesthetic protocol supports key Enhanced Recovery After Surgery (ERAS) principles, including early mobilization and reduced hospital stay. In carefully selected patients, such protocols may facilitate short-stay or outpatient laparoscopic surgery for advanced endometriosis, without compromising safety.

Strengths and Limitations

The strengths of this study include its prospective design, standardized perioperative protocols minimizing confounding variability, and serial pain assessments capturing postoperative pain dynamics in a real-world cohort of women with advanced endometriosis. Conducting the study at a high-volume tertiary center further enhances procedural consistency. However, several limitations warrant consideration. The modest sample size (n = 30) limits statistical power and precludes subgroup analyses between stage III and stage IV disease. The single-center design may affect generalizability, and outcomes were confined to the first 24 postoperative hours, without assessment of longer-term pain relief or disease recurrence. The absence of preoperative baseline pain scores restricts interpretation of relative pain improvement, and exclusion of ASA III or higher patients limits applicability to populations with significant comorbidities. Additionally, surgical complexity was not quantitatively stratified by adhesion burden, which may influence perioperative outcomes [18].

Clinical Implications and Future Directions

The findings of this study support the use of standardized general anaesthesia combined with multimodal analgesia as a first-line perioperative strategy for women undergoing laparoscopic surgery for rASRM stage III–IV endometriosis. Such protocols can achieve effective pain control while minimizing opioid exposure, aligning with current best practices and guideline recommendations [19].
Future research should focus on randomized controlled trials comparing different multimodal analgesic combinations, including

the addition of regional techniques such as transversus abdominis plane blocks, to further optimize postoperative pain outcomes. Longer follow-up periods and inclusion of patients with higher ASA grades would enhance the applicability of findings across broader clinical settings.

Conclusion

This prospective observational study shows that a standardized general anaesthesia protocol combined with multimodal analgesia provides safe and effective perioperative management for patients undergoing laparoscopic surgery for rASRM stage III–IV endometriosis. The approach was associated with stable intraoperative hemodynamics, satisfactory postoperative analgesia with limited opioid use, and early functional recovery, despite the complexity of advanced disease. Postoperative pain decreased progressively over 24 hours, and perioperative morbidity remained low. Overall, these findings support the routine implementation of structured perioperative strategies in advanced endometriosis surgery and highlight the need for larger, multicentre studies to further refine and validate anaesthetic and analgesic protocols.

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