Original Article

Dexmedetomidine Versus Dexamethasone for Prevention of Postoperative Nausea and Vomiting after Laparoscopic Surgery

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Abstract

Background: Postoperative nausea and vomiting (PONV) continue to be a common and unpleasant complication following laparoscopic surgery. The purpose of this study was to assess the efficacy of dexmedetomidine compared to dexamethasone in the prevention of PONV with general anaesthesia. **Material and Methods:** In this prospective, randomised, double-blind, controlled trial, 105 patients (ASA I–II, aged 18–60 years) scheduled for elective laparoscopic surgeries were allocated into three groups (n=35 each): Group I received dexmedetomidine one µg/kg IV, Group II received dexamethasone 8 mg IV, and Group III received normal saline. The incidence of nausea, vomiting, complete response (no PONV or rescue antiemetic), hemodynamic parameters, pain scores, and patient satisfaction were assessed over 12 postoperative hours. **Results:** In this prospective, randomised, double-blind, controlled trial, we enrolled a total of 105 adults patients (ASA I-II, ages 18-60 years) planned for elective laparoscopic surgeries and allocated subjects to three groups (n=35 each): Group I received dexmedetomidine one µg/kg IV, Group II received dexamethasone 8 mg IV, and Group III received normal saline. The incidence of nausea, vomiting, complete response (no PONV and no rescue antiemetic), hemodynamic parameters, pain scores, and patient satisfaction were assessed for 12 hours postoperatively. **Conclusion:** Dexmedetomidine (1 µg/kg IV) has better prevention and management of PONV after laparoscopic surgery in comparison to dexamethasone (8 mg IV). Dexmedetomidine offers antiemetic and analgesic benefits, maintaining stable hemodynamics and promoting patient satisfaction, thereby establishing itself as a safe and effective single-agent prophylactic for PONV.

Keywords: Dexmedetomidine, Dexamethasone, Postoperative nausea and vomiting, Laparoscopic surgery, General anaesthesia.

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Introduction

The occurrence of postoperative nausea and vomiting (PONV) continues to be one of the most prevalent and distressing complications of surgery with general anaesthesia. Approximately 30% of all surgical patients and up to 70% of high-risk patients experience PONV in the first 24 hours after surgery.[1] Although PONV is rarely life-threatening, it can have significant contributions to postoperative morbidity from dehydration, electrolyte imbalance, wound dehiscence, aspiration, delayed recovery, longer hospital stay, and decreased patient satisfaction.[2]

The causes of PONV are multifactorial in nature. Patient-related risk factors, such as female gender, non-smoking, and history of motion sickness or previous PONV, increase the risk. Surgical factors, including laparoscopic procedures, gynecological procedures, and middle-ear surgery, are associated with increased rates of PONV due to peritoneal insufflation (laparoscopic) and visceral manipulation (gynecological and middle-ear). Additionally, the type of anaesthetic technique influences PONV, as volatile anaesthetics, nitrous oxide, and perioperative opioids are known contributors. In 1999, the Apfel risk score was introduced to provide a practical and effective tool to predict PONV. The Apfel score includes four risk factors (female gender, non-smoker, previous PONV/motion sickness, and postoperative opioid use), with each risk factor predicting sequentially increasing PONV risks (10% to 80%).[6-8]

The emetic pathway involves several neurotransmitters and receptors, including serotonin ($5\text{-}HT_3$), dopamine (D_2), histamine (H_1), acetylcholine (M_1), and neurokinin (NK_1). Of the medication regimens, the most utilised agents for PONV [Postoperative nausea and vomiting] are the $5\text{-}HT_3$ antagonists, ondansetron and granisetron, although breakthrough nausea and vomiting are still prevalent in patients.[9] No single antiemetic is completely effective, and often combination therapy or multimodal therapy systems are the solution, especially in high-risk laparoscopic patients.

Dexamethasone, a powerful synthetic glucocorticoid, has proven successful in preventing PONV due to its anti-

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inflammatory properties, central antiemetic mechanisms, and its capacity to inhibit the release of serotonin, modulate neurotransmitter activity, and diminish postoperative pain and overall opioid requirement.[10] Dexamethasone is typically given as a single-dose perioperative regimen and is well tolerated, including additive effects in combination with other antiemetics.[11] Dexmedetomidine is an α_2-adrenoceptor agonist with a selective and highly attractive profile of sedation and analgesia without significant respiratory depression.[12] Dexmedetomidine has potential for a decrease in cerebral emetogenic triggers by reducing sympathetic tone, opioid consumption, and anaesthetic requirements. Furthermore, it inhibits central noradrenergic neurotransmitter release, which may also serve a role as a substance for its antiemetic effects.[13,14] Although numerous agents are available, the prevention of postoperative nausea and vomiting (PONV) following laparoscopic surgery remains one of the most difficult areas of clinical practice. The majority of the literature to date has focused on the use of serotonin antagonists or corticosteroids; however, limited evidence addresses the use of other newer agents such as dexmedetomidine. The increased popularity of laparoscopic surgery and the continued emphasis on reducing postoperative recovery time highlight the necessity for an effective, safe, and non-sedating postoperative nausea and vomiting regimen.[15] Thus, this study aims to evaluate the efficacy of dexmedetomidine compared to dexamethasone in cases of postoperative nausea and vomiting among laparoscopic surgical patients, and to assess secondary outcomes, including hemodynamic parameters, postoperative analgesic consumption, patient satisfaction, and adverse events, thus contributing to evidence-based perioperative strategies for the minimisation of PONV and improving recovery.

Materials and Methods

A prospective, randomised, double-blind, comparative control study design was employed and conducted within the Department of Anaesthesiology and Critical Care, Netaji Subhash Chandra Bose Subharti Medical College and Chhatrapati Shivaji Subharti Hospital, Meerut, Uttar Pradesh, India, with approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants in the study.

Study Population: The study involved 105 adult patients between the ages of 18 and 60, classed as ASA physical status I or II, who were scheduled for elective laparoscopic surgery under general anaesthesia. Patients were randomly divided into three equal groups of 35 using a computer-generated randomisation table.

Group Allocation -

- Group I (Dexmedetomidine Group): Received dexmedetomidine one µg/kg intravenous (IV), diluted in 10 ml normal saline, over 10 minutes before induction.
- Group II (Dexamethasone Group): Received dexamethasone 8 mg IV, diluted in 10 ml normal saline, over 10 minutes before induction.
- Group III (Control Group): Received 10 ml of normal saline IV over 10 minutes before induction.

Inclusion Criteria

- Patients aged 18 to 60 years, of either sex.
- ASA Grade I to II.
- Scheduled for elective laparoscopic procedures under general anaesthesia.

Exclusion Criteria

- Previous PONV or history of motion sickness.
- Hypersensitivity to any of the study drugs.
- Patients receiving antiemetics, steroids, or α^2-adrenergic drugs.
- Pregnant or breastfeeding women.
- Patients with uncontrolled hypertension, diabetes mellitus, or cardiac, renal, or hepatic dysfunction.

Preoperative Preparation: All patients were kept nil per os (NPO) for at least 8 hours before surgery. All patients received standard premedication with injection midazolam 0.02 mg/kg IV and glycopyrrolate 0.2 mg IV. Upon arrival in the operating room, routine monitoring was established, including ECG and non-invasive blood pressure. Anaesthetic Approach: Once intravenous access was established, the study medication (as per group allocation) was administered over a 10-minute infusion. Induction of anaesthesia was created with propofol 2 mg/kg, fentanyl two µg/kg, and succinylcholine 2 mg/kg for endotracheal intubation. General anaesthesia was maintained with a combination of oxygen and nitrous oxide (50:50) as well as sevoflurane 1-2%. Muscle relaxation was achieved with atracurium 0.5 mg/kg before intermittent doses were administered. Ventilation was controlled to maintain end-tidal CO_2 of 35-40 mmHg. At the end of surgery, residual neuromuscular block was reversed with intravenous neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. All patients were extubated upon recovery and transferred to the postoperative care unit.

Primary Outcome Measures:

Incidence of post-operative nausea and vomiting (PONV) for the first 12 hours after surgery.

Complete response (no nausea or vomiting, or requirement for rescue antiemetic)

Secondary Outcomes:

- Hemodynamic parameters (heart rate, mean arterial pressure).
- Post-operative pain score on a Verbal Descriptive Scale (VDS).
- Rescue antiemetic requirement (injection ondansetron 4 mg IV).
- Patient satisfaction score
- Adverse effects (e.g., bradycardia, hypotension, sedation).

Patients were monitored at intervals of 0-15 minutes, 15 minutes-2 hours, 2-6 hours, and 6-12 hours postoperatively for nausea, vomiting, or any other side effects. Hemodynamic parameters were documented intraoperatively and also during the same postoperative intervals used for monitoring for side effects. All data were documented and statistically analysed by using SPSS software version 23.0. Continuous variables were documented as mean ± standard deviation (SD) and statistically analysed using Student's t-test or ANOVA. Categorical data was analysed using the Chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Baseline Characteristics of Study Participants (n = 105)

Parameter	Group I (Dexmedetomidine)	Group II (Dexamethasone)	Group III (Control)	p-Value
Age (years, Mean ± SD)	37.8 ± 9.6	38.2 ± 8.9	39.0 ± 9.3	0.87
Gender (M/F)	14/21	15/20	13/22	0.92
Weight (kg, Mean ± SD)	61.2 ± 8.4	62.0 ± 7.9	60.9 ± 9.1	0.81
ASA Grade I / II (%)	68.6 / 31.4	71.4 / 28.6	65.7 / 34.3	0.77
APFEL Risk Score (Mean ± SD)	2.4 ± 0.7	2.5 ± 0.8	2.6 ± 0.6	0.74
Type of Surgery (Cholecystectomy / Appendectomy / Others)	40 % / 35 % / 25 %	37 % / 37 % / 26 %	42 % / 34 % / 24 %	0.89

All three groups were demographically comparable ($p > 0.05$), confirming successful randomization and baseline homogeneity among participants.

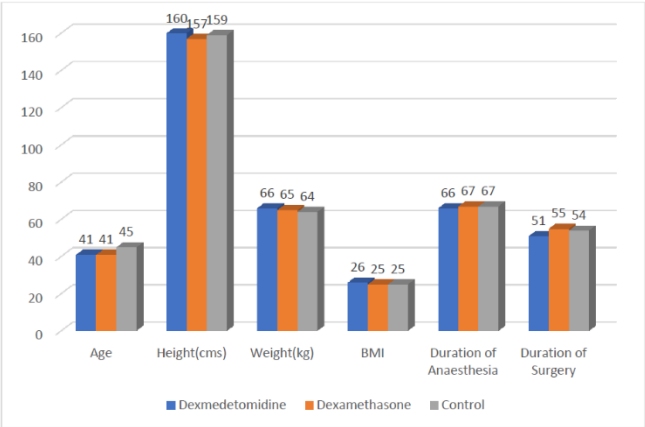

Figure 1: Comparison of Baseline Parameters among Study Groups

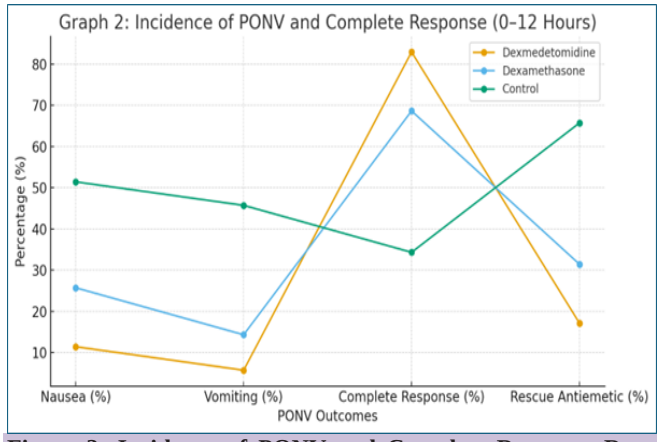

Figure 2: Incidence of PONV and Complete Response Rate across Groups (0–12 Hours)

A bar graph was used to demonstrate the mean age, sex ratio, and ASA grade distribution. Since the two groups were comparable for these variables, it can be concluded that there were no statistically significant differences in baseline demographic or surgical characteristics. Thus, any differences in outcome would not be attributed to inherent patient variation, as they did not show intergroup statistical significance.

Clustered bar graph showing higher complete response and lower nausea/vomiting frequency with dexmedetomidine. Dexmedetomidine produced the highest complete response and lowest emetic frequency, establishing superior efficacy in preventing postoperative nausea and vomiting compared to dexamethasone or placebo.

Table 2: Clinical Outcomes and Incidence of PONV (0–12 hours Postoperative)

Parameter	Group I (Dexmedetomidine)	Group II (Dexamethasone)	Group III (Control)	p-Value
Nausea (%)	11.4 %	25.7 %	51.4 %	<0.001
Vomiting (%)	5.7 %	14.3 %	45.7 %	<0.001
Complete Response (%)	82.9 %	68.6 %	34.3 %	<0.001
Rescue Antiemetic Required (%)	17.1 %	31.4 %	65.7 %	<0.001
Mean Episodes of PONV (Mean ± SD)	0.21 ± 0.4	0.37 ± 0.6	1.2 ± 0.8	<0.001

Dexmedetomidine significantly reduced the incidence of PONV and need for rescue antiemetic compared to dexamethasone and control groups ($p < 0.001$).

Table 3: Secondary Parameters: Pain, Hemodynamics, Satisfaction, and Adverse Events

Parameter	Group I (Dexmedetomidine)	Group II (Dexamethasone)	Group III (Control)	p-Value
VDS Pain Score (0–12 hrs, Mean ± SD)	1.8 ± 0.7	2.5 ± 0.8	3.1 ± 1.1	<0.001
Mean Heart Rate (bpm)	74.2 ± 8.3	80.5 ± 7.9	83.4 ± 8.7	<0.001
Mean Arterial Pressure (mmHg)	84.5 ± 6.8	88.3 ± 7.2	90.1 ± 8.1	<0.05
Patient Satisfaction Score (1–5)	4.6 ± 0.4	4.0 ± 0.6	3.2 ± 0.7	<0.001
Adverse Effects (Bradycardia / Hypotension / Sedation) (%)	5.7 / 8.6 / 2.9	0 / 2.9 / 0	0 / 0 / 0	>0.05

Dexmedetomidine maintained stable hemodynamics, provided superior analgesia, and achieved higher patient satisfaction, with minimal adverse effects.

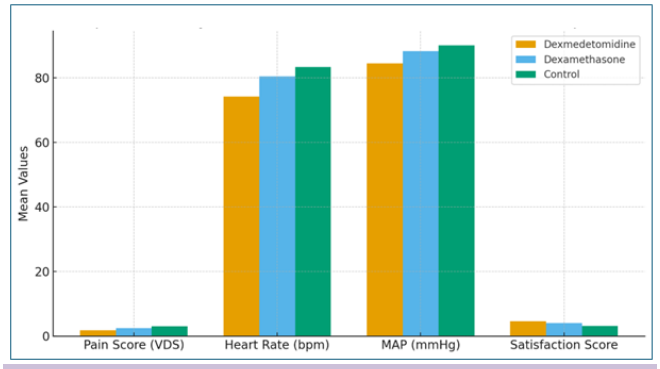

Figure 3: Comparison of Hemodynamic Parameters and Pain Scores

[Figure 3] showed trends for HR and MAP throughout the intraoperative period and into the postoperative period. The dexmedetomidine group maintained the lowest stable values and had the lowest pain scores. Dexmedetomidine demonstrated hemodynamic stability while providing an optimal mechanism for analgesia, and collectively, this had a positive effect on the satisfaction/effectiveness of analgesia, as well as reducing overall postoperative nausea and vomiting.

Discussion

This randomised, double-blind, comparative control study was done to assess and compare the effectiveness of dexmedetomidine and dexamethasone for preventing postoperative nausea and vomiting (PONV) in patients presenting for laparoscopic surgery under general anaesthesia. In this study, dexmedetomidine demonstrably decreased the incidence of postoperative nausea and vomiting, reduced the need for rescue antiemetics, and increased patient satisfaction when compared to both the dexamethasone and control groups. The groups were similar in demographic characteristics, ASA grading, and type of surgery; therefore, it is reasonable to assume that the differences noted were due to the medications and not due to variations in baseline characteristics.

Incidence of PONV: In the present study, dexmedetomidine produced an incidence of 11.4% for nausea and 5.7% for vomiting within 12 hours postoperatively. Dexamethasone produced 25.7% nausea and 14.3% vomiting, in the PONV group, whereas the control group experienced 51.4% nausea and 45.7% vomiting, respectively. Acomplete response (no nausea, vomiting, or rescue antiemetic use) was noted in approximately 82.9% of the dexmedetomidine group, which was significantly higher than in the dexamethasone group (68.6%) and the control group (34.3%) ($p < 0.001$).

The results match Modir H et al (2019), who also found a significant decrease in PONV with the use of perioperative dexmedetomidine by reducing the need for opioids and higher volatile agents in PONV.[16] Ali et al. (2013) also noted a lower incidence of PONV with dexmedetomidine 1 µg/kg in patients undergoing laparoscopic cholecystectomy.[17] Similarly, Zhang et al. (2018) strengthened the evidence with their findings that dexmedetomidine reduces PONV by reducing sympathetic activity, which can inhibit the release of 5-HT and modulate the chemoreceptor trigger zone.[18,19]

Comparison with Dexamethasone: For many years, dexamethasone has been known as an efficacious prophylactic antiemetic. In our study, dexamethasone was associated with a moderate reduction in PONV compared to placebo, although it was inferior to dexmedetomidine in reducing nausea. This has been demonstrated in studies by Wang et al. (2015) and Kiran et al. (2017), where a single administration of 8 mg dexamethasone was more effective at reducing postoperative nausea than a placebo, but not as effective as other antiemetics.[20,21]

The proposed mechanism of the antiemetic effect of dexamethasone involves the inhibition of central prostaglandin synthesis, decreased serotonin secretion from the gut, and modulation of the nucleus tractus solitarius. Alternatively, dexmedetomidine had benefits including α2-adrenoceptor-mediated sympatholysis, reduction of opioid consumption, and attenuation of stress responses, resulting in a more favourable antiemetic effect.

Analgesia and Hemodynamic Stability: The quantification of pain was significantly less in the dexmedetomidine group (mean VDS 1.8 ± 0.7) compared to patients in the dexamethasone group (2.5 ± 0.8) and the control group (3.1 ± 1.1), demonstrating the established analgesic-sparing properties of dexmedetomidine. Bhattacharjee et al. (2015) and Eren et al. (2016) also reported findings on reduced analgesic requirements and improved postoperative comfort with the administration of dexmedetomidine.[22,23]

Hemodynamic stability was well preserved for all groups, albeit heart rate and mean arterial pressure were slightly lower for the dexmedetomidine group, which could be a reflection of its central sympatholytic mechanism. These results are consistent with previous studies by Mukhtar and Obiyah (2006) and Marana et al. (2008), which documented stable intraoperative hemodynamics, a reduced stress response, and no adverse effects.[24,25]

Adverse events and safety Profile: Adverse events of a minor nature, including bradycardia (5.7%) and transient hypotension (8.6%), were reported with dexmedetomidine, although these were mild and characteristic of a transient phenomenon, and not clinically significant. There was no indication of any respiratory depression, deep sedation, or any significant adverse event beyond those reported, which is indicative of dexmedetomidine's favourable safety profile and was also observed in the studies by Tufanogullari et al. (2008) and Hong et al. (2014).[26,27]

Overall, the study suggests that dexmedetomidine may offer various perioperative advantages, including antiemetic, analgesic, and sympatholytic properties, without the endocrine and metabolic side effects typically associated with long-term steroid use. Its use in anaesthetic regimes for laparoscopic procedures has the potential to improve patients' comfort and recovery significantly. The study was limited due to the short follow-up period (12 hours) and being performed at only a single centre. No data were collected to assess additional efficacy beyond the immediate post-operative phase or the

effects of multimodal therapy. Future multi-centric trials with a larger sample size and multimodal comparisons, such as dexmedetomidine + ondansetron, would help identify additional protocols that offer benefits in these areas.

Conclusion

This double-blind, randomised, comparative study provides evidence that dexmedetomidine (1 µg/kg IV) is significantly more effective than dexamethasone (8 mg IV) in preventing postoperative nausea and vomiting (PONV) in patients undergoing laparoscopic surgery under general anesthesia. Compared to the dexamethasone and control groups, dexmedetomidine showed markedly higher rates of complete response (82.9% vs. 50% and 62.7%, respectively), lower rates of nausea and vomiting, and a lower need for rescue antiemetics. In addition, dexmedetomidine provided good postoperative analgesia, hemodynamic stability, and higher patient satisfaction, all without any significant adverse effects, preoperatively.

The authors postulate that the antiemetic and analgesic aspects of dexmedetomidine may relate to its α_2-adrenoceptor agonism, sympatholytic and opioid-sparing effects, and reduction of stress-mediated emetic pathways. Dexamethasone certainly remains a valid antiemetic with demonstrated efficacy, but it has limitations as a single agent for prophylaxis.

Overall, dexmedetomidine appears to be an effective and safe single agent for preventing PONV after laparoscopic surgery as it provides antiemetic and analgesic properties while maintaining smooth recovery postoperatively and improving patient comfort and satisfaction and therefore is a valuable addition for modern multimodal anaesthetic management.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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